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JANUARY 2, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

JAN 1961
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*Helicopter Delivers Mercury Capsule to Carrier*

Kennedy Starts Space Policy Overhaul ..... 23
First Details of Mariner Guidance .....
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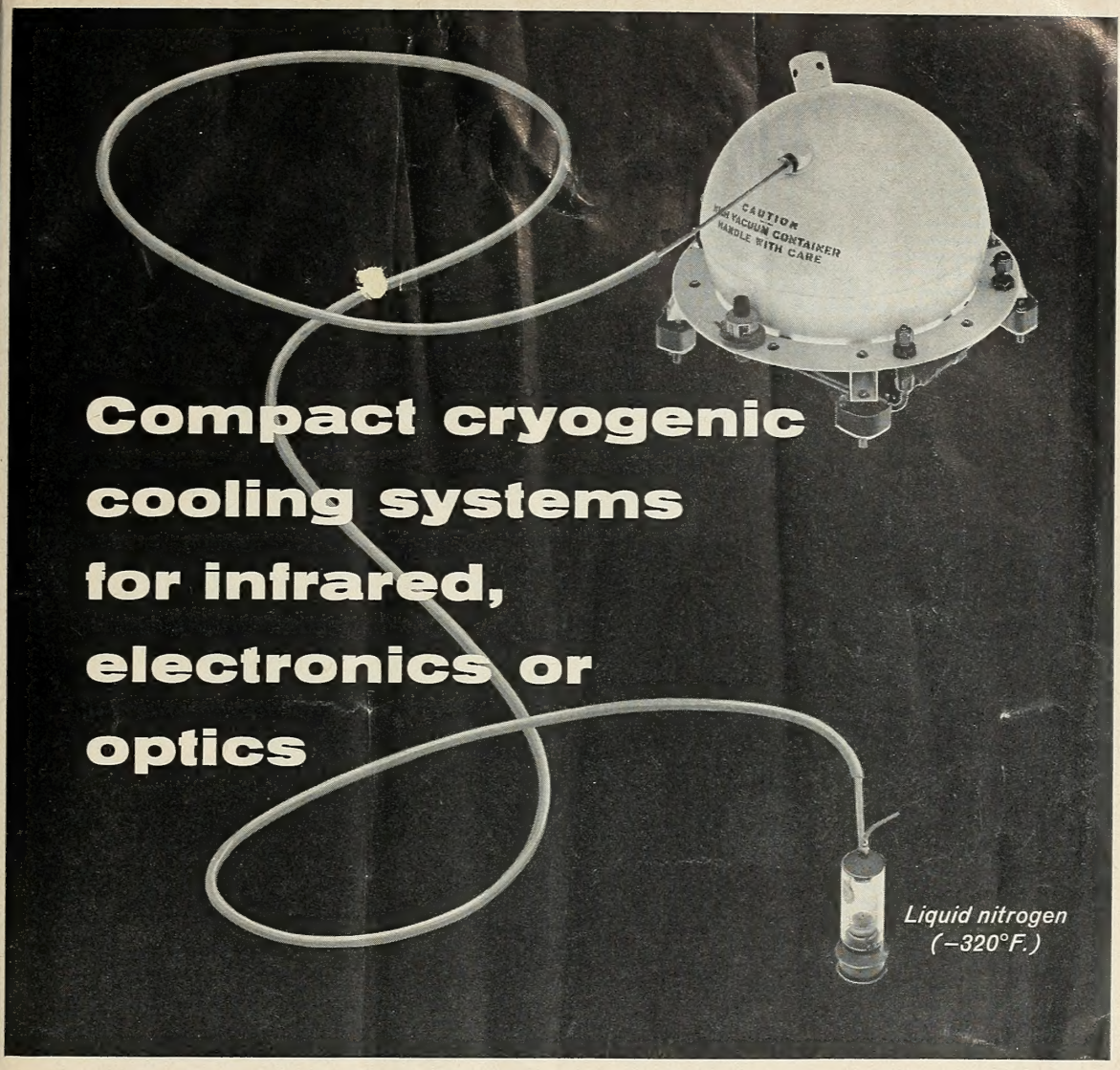
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THE DAY of operational weather satellites is one step closer with the orbiting of the National Aeronautics and Space Administration's Tiros II.

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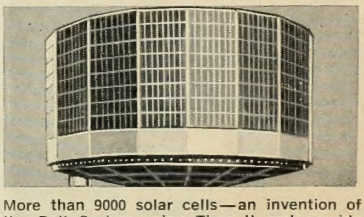
But despite its many instruments—TV cameras, tape recorders, solar cells and antennas—Tiros II would not be as useful if it were not in a nearly perfect circular orbit, made possible in large measure by the Bell Telephone Command Guidance System.

To provide accurate weather data, the satellite must be at an almost uniform distance from the earth at all times. Tiros II's orbit varies within extremely narrow limits as it constantly circles the earth.

Our Command Guidance System for the Tiros launching vehicle is a result of research and development by Bell Telephone Laboratories and production by Western Electric. This amazingly accurate system has scored many other successes in America's space program.

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 1 January 2, 1961

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## THE COVER

*U.S. Marine helicopter which recovered the MR-1 Project Mercury spacecraft approaches deck of USS Valley Forge. For a report on the Mercury outlook, see story on Page 20.*

## JANUARY 2 HEADLINES

Kennedy Starts Overhaul of U.S. Space Policy ..... 12
First Details of Guidance for NASA's Mariner ..... 14
First Photos of Nike-Zeus Being Assembled ..... 16
NASA Concerned by Atlas-based Launch Failures .... 17
Tiros-type Weather Satellite System Weighed ..... 18
Report Urges Study of Space Impact on Mankind .... 18
Next Mercury Redstone Flight to Carry Chimpanzee .. 20
Martin Now Strictly a Missile/Space Business ..... 37
Astropower Outlines Big Propulsion R&D Plans ..... 39

## SPACE MEDICINE

Martin Seeks to Keep Man Efficient in Space ..... 19

## SPECIAL SECTION

Latest Edition of M/R's Astrolog—An Up-to-Date Status Report on all U.S. missile and space programs and all satellites now in orbit ..... 23

## ELECTRONICS

Minuteman Flight Controls Aim at Low Maintenance .. 32
Cesium Beam Leading to Better Timing Accuracy .... 34
Raytheon Device Measures Composition of Gases .. 34
SOCOM Offers Improved Space Communications .... 35

## ADVANCED MATERIALS†

TFE Resin Successfully Withstands Radiation ..... 36

## INTERNATIONAL

European Space Research Organization Due in Year .. 38

## DEPARTMENTS

The Countdown ..... 9
The Missile/Space Week† ..... 17
Technical Countdown . 31
Industry ..... 39
Editorial ..... 50
Products & Processes .. 41
Contracts ..... 45
Names in the News .. 47
Letters ..... 48
When and Where .... 49

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The missile: TITAN I, shown here in its first stage-separation flight. The power plants: liquid-propellant rocket engines—designed, developed, and manufactured by Aerojet-General's Liquid Rocket Plant.

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# The Countdown

## WASHINGTON

### Mahon—More DOD Money

Indication of how Congress will handle the FY '62 DOD budget comes from Chairman George Mahon of the House Defense Appropriations subcommittee. Says Mahon: more should be spent on certain key missile and space programs the need for which the present administration has been a "little tardy" in recognizing. But, he is for a balanced budget and against any "vast new program of expenditures."

### Kennedy Snub?

COUNTDOWN hears Chairman Overton Brooks of the House Space Committee is unhappy over not being invited to President-elect Kennedy's Palm Beach space conference. Insiders say Brooks may be "embarrassed" enough to make things difficult in the next session of Congress. What really irked him: Vice president-elect Johnson, after picking up the chairman-designate of the Senate Space Committee, Sen. Robert Kerr, in Oklahoma City, flew right over Brooks' home in Shreveport, La. Was the snub deliberate? Some politicos point out that it could have been—on grounds that Brooks was a less-than-enthusiastic Kennedy supporter during the campaign.

### Discoverer Monkey Shot

Long-delayed first attempt to recover a monkey from orbit in a *Discoverer* capsule is now expected sometime in February. The monkey could go aboard *Discoverer XXI*, after one more shot in the series. *Discoverer XIX*, which was fired into orbit Dec. 19, was designed to test the new *Agena B* satellite and contained instrumentation to gather information on background radiation in support of the *Midas* IR missile detection satellite system.

### Minuteman Shot Slips

First shot of a full scale *Minuteman* ICBM from a silo at the Cape has now slipped until late January or early February. It had been scheduled to go in December. But troubles developed with the GSE installation. The Air Force says the slippage will not affect the operational date of the first squadron, set for mid-1962.

### Eisenhower Cuts

Both the Air Force and Navy claim their respective *Skybolt* and *Eagle* R&D programs are not being jeopardized by the cuts inflicted in the proposed Eisenhower DOD budget. The AF wanted $150 million for *Skybolt* in '62 and was knocked down to $80 million. (The whole R&D program for the ALBM is estimated at $400 million, of which $150 million is now programed through FY '62.) While the *Eagle* air-to-air missile itself may not be hurt, the Navy is pessimistic about saving the Missileer plane to carry it. Present indications are that the Eisenhower budget will eliminate the missileer altogether.

### All-in-one ASP

Secret requirement the AF hopes to make stick in the proposed ASP (aerospace plane) is to make it a multi-mission spacecraft. This would include offensive, defensive, reconnaissance and logistic missions in space. The AF is seeking $20 million for ASP, a rocket-powered vehicle which can operate both in the atmosphere and in space.

### What Race?

Will the U.S. be able to match the Soviet promise to set up a moon base on the 50th Anniversary of the Bolshevik Revolution—in 1967? The chances are slim, if one story is to be believed. It seems the Air Force laid out a step-by-step program to establish a lunar base by 1968. But, having no "mission" in space under Eisenhower policy, the AF offered the program to NASA. The result: NASA said, "Sorry—no money in the budget." As of now there is no funded U.S. plan to put a base on the moon.

## INDUSTRY

### Navy Moves on Hydrofoils

Proposals are due in about 60 days on the design and production of a 300-ton, 50-knot hydrofoil craft to be ready for testing in 24 months. Busships is expected to solicit proposals soon on a 500-ton hydrofoil in the 60-80 knot bracket.

### AF Navy CB Funds Set

Surviving the wring-out in the Eisenhower FY '62 budget are funds for the AF and Navy to develop chemical and bacteriological warfare weapons. This has been generally an Army activity up to now, and the Army thought it was time someone else helped pick up the check.

### Fight for Range Ship

Rough scramble is about to start on contracts for the $51.6 million job of converting and instrumenting two tracking ships for the Atlantic Missile Range. Several companies are in the competition. It's understood, incidentally, that bids will be reviewed carefully by DOD Research and Engineering.

## INTERNATIONAL

### A-Test for Tactical Missile

Best bet on the purpose of the third French A-test in the Sahara Dec. 27 is that it was to test an R&D warhead for a tactical missile. The atomic explosion was of low yield.

### Soviet Underwater Missile Tracker

Intelligence sources are saying the Soviet survey ship "Shokalsky" in the Pacific is outfitted for tracking underwater missile launchings from Russian submarines. The ship put into Suva, Fiji, recently for repairs. It is the same one which recently fired some weather rockets.

### Overseas Pipeline

Two infantry divisions of the Belgian army are being equipped with the French-made *Entac* anti-tank missile . . . Operational tests of the French *Masurca* anti-aircraft missile are due to begin in March. The missile is slated for sea duty in 1962 . . . There's still optimism in Britain that the *Blue Streak* will be used for space research, but France has all but thumbed down participation in a joint program using this booster.



The most proven large ballistic missiles, the Atlas (left) and Redstone (right), will launch America's Astronauts. Main-stage engines of both are by Rocketdyne.

# AMERICA'S ASTRONAUTS WILL BE LAUNCHED INTO SPACE BY ROCKETDYNE ENGINES

America's man-in-space programs demand the ultimate in reliability. There is no room for error—that is why America's most experienced rocket engines have been chosen for the job.

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A Redstone engine, whose performance over a decade of development includes 62 consecutive successful flights, will loft the first manned space craft high over the Atlantic in an exploratory ballistic arc.

Then an Atlas system of five engines, proven in more than 60 development and operational flights, will send a man soaring upward more than 100 miles to circle earth for four hours during man's first orbital flight in space.

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*Rocketdyne engines have launched more than 250 missiles, satellites, and space probes.*

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# Missile/Space Policy Changes Begin

## *Kennedy weighs problems of military space bid, nuclear strategy, space slippage; Johnson, Gilpatric named to key roles*

**by James Baar**

PRESIDENT-ELECT KENNEDY appeared this week to be preparing to accelerate and strengthen the nation's missile and space programs. But the question of how far he would go and where still remained unanswered.

Among the issues involved in this overall question were:

–The military call for freedom to develop space weapons and greatly expand the military role in space.

–The size of NASA's space efforts and the slippage of America's only heavily financed man-in-space program, Project *Mercury*.

–The internal Pentagon conflict over the best nuclear strategy and its direct affect on the U.S. arsenal of big missiles—including R&D and procurement programs for both strategic ICBM's and active defense systems such as *Nike-Zeus*.

Related issues include possible resumption of U.S. nuclear testing and further tinkering with the organization of the Armed Forces.

How quickly and in what direction Kennedy moves in these areas will offer clear indications of whether he will fulfill his campaign pledges to expand greatly U.S. defense and space programs. The immediate indications were that in space activities, at least, he would move cautiously at first.

• **Council upgraded**—Two of Kennedy's more potentially significant moves to date in this area are the appointments of Vice President-elect Lyndon Johnson as chairman of the National Space Council and Roswell Gilpatric as Deputy Defense Secretary.

The Space Council, originally proposed by the White House, was designed to aid the President in formulating overall policies for operations in space by the Pentagon and NASA. The nine-man Council includes the Secretaries of Defense and State, the AEC Chairman, the Administrator of NASA, one other member from within the government and three more from outside the government. Its composition could give it much force.

However, in practice, President Eisenhower used it little except as a rubber stamp for his space policies which authorized generally modest-scale activities by NASA and extremely limited activities by the military services. Last year, Eisenhower proposed that the Space Council be abolished.

The House approved the Eisenhower proposal, but Johnson, as Senate Majority Leader and Chairman of the Senate Space Committee, had the legislation pigeonholed. Johnson said in a statement in August:

"The next President could well have different views as to organization and functions of the military space programs. Any changes in the Space Act at this session will have little or no effect on the space programs during these next few months but could restrict the freedom of action of the next President."



*PRESIDENT-ELECT, Vice President-elect Johnson (center), named chairman of the Space Council, and Sen. Kerr, chairman-designate of Senate Space Committee.*

• **Staff to grow**—Under the National Space Act, the principal function of the Council outside of aiding the President in determining national goals in space is to help determine which agency of the government will accomplish them. The Act authorizes the Council to employ a permanent staff headed by an executive secretary whose appointment must be confirmed by the Senate.

The executive secretary would be paid $20,000 a year. He could appoint without regard to Civil Service regulations three staff members. They could be paid $19,000 a year each. No such high-powered staff was ever appointed under the Eisenhower Administration.

However, Johnson could. He also could use the Council to help remold U.S. space policies and present roles and missions in space. The staff could be used to maintain a continuing survey of U.S. space activities to make certain that the new policies were being followed.

How bold a role Johnson actually would play remained to be seen. As Senate Majority Leader and Space Committee Chairman, he made a number of statements over the last several years deploring the U.S. Space Lag. However, despite his powerful position in a Democratic-controlled Congress, his committee never did more than tinker with the Administration's budget requests for NASA.

• **Duplication doubtful**—Another question raised by the Johnson appointment is what effect it might have on the technical advice the President presently receives from such review groups as the Office of the Presidential Scientific Adviser, the Office of the Defense R&E Director and the top technical officials at NASA.

There is the possibility the council could introduce another duplicating layer in the already many-layered government structure. But this need not happen if the Council staff remains small and restricts its activity to reviewing programs only for broad policy decisions.

It is precisely in this maze of many-layered government that Gilpatric may prove most helpful as the new No. 2 official in the Pentagon.

Ford President Robert S. McNamara, Kennedy's choice for Defense Secretary, is expected to provide both fiscal know-how and the imagination of a keen mind. But it is Gilpatric who, from his past tour of duty in the Pentagon as Air Force Undersecretary and subsequent study assignments, knows where many of the bodies are buried.

• **Easy on reorganization**—Gilpatric has been an outspoken critic of military duplication. He also helped Sen. Stuart Symington (D-Mo.) write the recent report calling for radical reorganization of the Pentagon.

However, no such radical reorganization appears to be in the offing, at least for some time. Kennedy has been most cool to the Symington recommendations. Few cheers have come from congressional leaders. And McNamara has stated flatly: "I will undertake no major reorganization of the Defense Department in the immediate future."

The prospect as the Kennedy Administration takes office is for some gradual readjustments in the Pentagon —possibly the elimination of some of the reviewers who review reviewers.

• **Sticky budget**—The defense budget, rather than reorganization, is the immediate main concern of Kennedy, McNamara and Gilpatric. The Eisenhower Administration is leaving them with parting defense budget carefully designed to cause them a maximum of fiscal embarrassment.

By repeated redrafting and causal reslicing, the Administration has put together a final overall budget for FY 1962 that will have the happy merit of being balanced.

However, to do this, military service requests have been cut to somewhat under $42 million by drastically holding down spending on a wide variety of programs aimed at giving the United States military superiority in the mid and late 1960's.

This budget, by Kennedy's standards as expressed during the election campaign, is no more adequate for rebuilding American power in the world than the last one. Its significance when Eisenhower sends it to Congress this month is mainly in its role as an indicator of Kennedy actions.

Kennedy is expected in some circles to increase the FY 1962 defense budget by $2 billion to $3 billion. He also may submit a sizable supplemental money bill for FY 1961. However, still more may be needed.

Two key factors are whether he reverses the Eisenhower Administration policy that the military have little business in space and which major missile and military space systems he decides the nation needs.

All are costly. But some are more costly than others. ⌘

## 'Fine-tooth comb' readied . . .

*The first details of any changes in U.S. space policies and programs under the Kennedy Administration are now expected to be disclosed in late January at the earliest.*

*President-elect Kennedy has ordered an exhaustive study of all current space programs and proposals at the Pentagon and NASA before deciding what changes he might make.*

*Vice President-elect Lyndon Johnson, newly named chairman of the National Space Council, is taking overall charge of the review.*

*Meantime, Johnson confined himself to predicting that Kennedy will launch a "very vigorous and accelerated space program."*

*He also added that presently planned spending on all U.S. space programs in FY 1962 would be about $2 billion and forecast it would rise to about $5 billion in FY 1965. He did not make clear whether the increases would come about quickly.*

*Kennedy conferred this last week at Palm Beach with Johnson and Sen. Robert Kerr (D-Okla.), the man expected to succeed Johnson as chairman of the Senate Space Committee.*

*Johnson said afterwards that once the studies are completed funds will be provided to "see to it that America forges ahead in the space field." But he said first Kennedy wanted present programs reviewed with a "fine-toothed comb."*

*Kerr struck much the same cautious theme. He said the new Administration must give current programs "close study and scrutiny." He noted pointedly that financial projections for space planning were running far ahead of actual current spending.*

*Underlying their statements was the feeling by a number of Kennedy Administration advisers that some U.S. space programs both current and planned are not worth their fancy pricetags—that these programs should be redirected or the money should be spent elsewhere.*

## U.S. may be year behind Reds . . .

# Mariner Carries Planet Fly-by Hopes

***First details guidance planned for shot past Venus; infrared scanner is key to locating planet from figure 100,000 miles out.***

by William Beller and Richard van Osten

AMERICA MAY BE a full year behind Russia in making the first attempt to explore the planets.

Present U.S. timetable of space exploration now calls for a fly-by of Venus sometime during the third quarter of 1962—18 months from now. However, Venus will be in a favorable position for a fly-by starting this July —and it is possible a Soviet attempt could come then.

Leadtimes in the development of the *Mariner* spacecraft and *Centaur* vehicle are forcing into next year at the earliest the U.S. Venus fly-by, a shot designed to give a close-up instrumented "look" at the cloud-wreathed planet.

Officials of NASA's Jet Propulsion Laboratory, which is in charge of the *Mariner* program, will depend heavily on a series of earlier *Ranger* shots for launch experience and system development. There also will be some *Mariner* shots before Venus becomes a target.

One of the major questions in the fly-by program is money. It is not yet known if one or more complete backup vehicles will be available for launching during the month that Venus is in optimum position in 1962. Should only one be available—and that fails—another 18 months would pass before the planet would be in the proper position.

Nor is this all.

Even if the launch goes well, it will be a ticklish technical feat to properly orient the 50-75 lb. payload in the 1000-lb. *Mariner* so that it will find the planet. The key instrument in locating Venus from 100,000 miles out will be an IR scanner.

• **Assignments**—The system will then lock on and track. A horizontal platform containing the instrumentation package will be pointed at the center of Venus. Exploration from this distance will include:

–Spectroscopy in ultraviolet and visible spectrum.

–Field and particle measurements.

### Best Years for Launching Flights to Venus and Mars

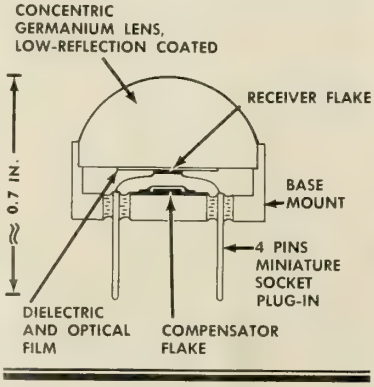
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| 1965 | VENUS | |
| 1966 | | MARS |
| 1967 | VENUS | |
| 1968 | | MARS |
| 1969 | VENUS | |
| 1970 | VENUS | |

–Cosmic ray and dust measurements.

–General radiation measurements of the planet in millimeter and centimeter wavelengths.

Proportional telescopes may be used to aid in determining the location of *Mariner* at the time of data transmissions back to earth.

Position of the spacecraft in relation to Venus, the sun and earth, moreover, will be critical for data integrity and transmission. This means the system must keep the spacecrafts solar cells (capable of delivering 300 watts raw power) pointed at the sun while highly directional antennas are pointing at the earth.




*DETAILS: immersed thermistor bolometer.*

The orientation system is being developed for JPL by Barnes Engineering Co., of Stanford, Conn.

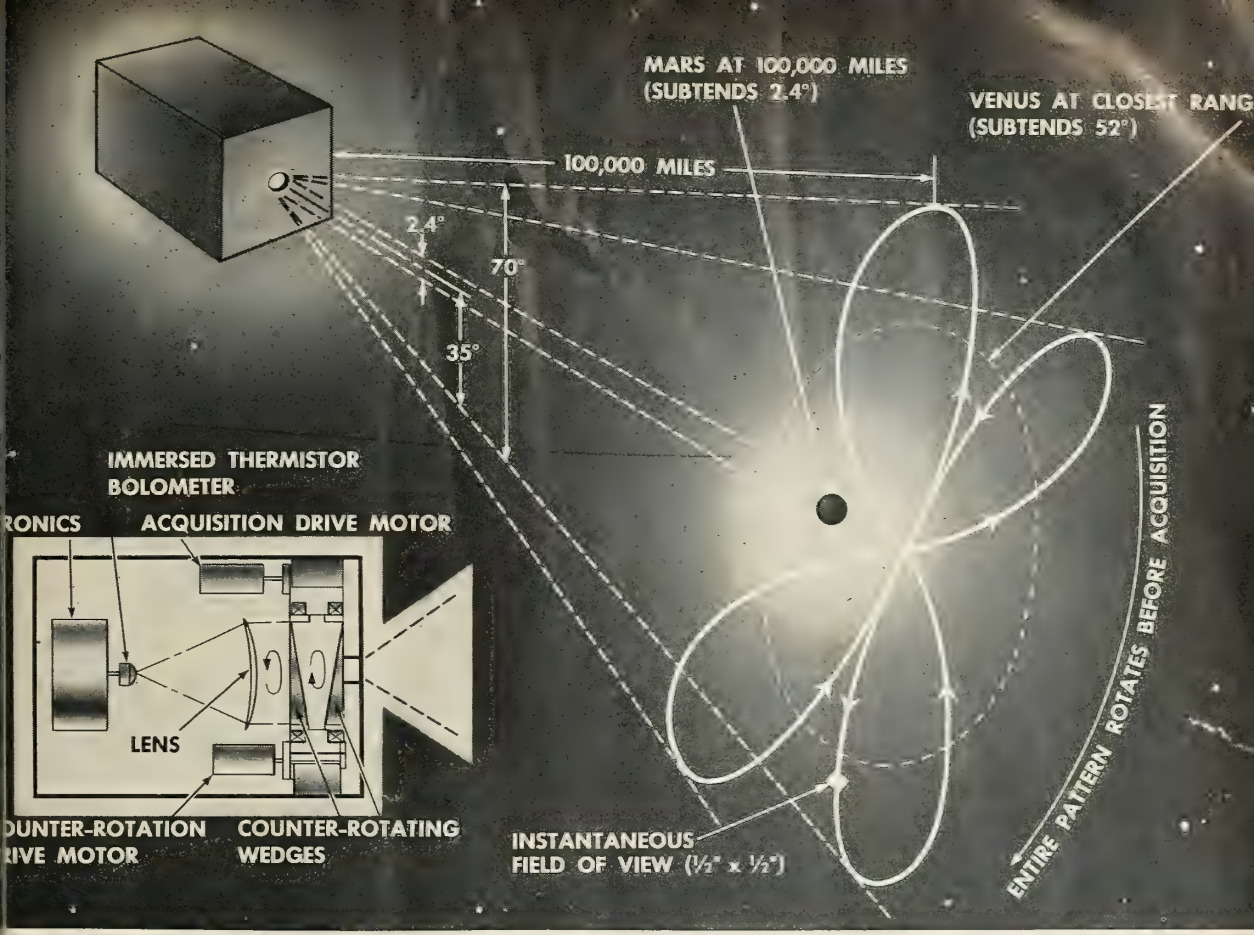
At the present time, the *Mariner* program comprises seven interplanetary missions, all Venus and Mars fly-bys. The first launching of a prototype of the Mars spacecraft is scheduled for 1963. This will be a development mission and a prelude to a 1964 Mars fly-by.

Toward the end of the present decade, the *Mariners* will give way to *Voyagers* which will be using *Saturn* C-1 and C-2 launch vehicles. These will be able to carry more than 20,000 pounds payload and will be used for planetary orbiters and orbiter-landers.

In the *Mariner* probes, the sensors must have high sensitivity because only small amounts of IR radiations will be coming from the target planets. The IR from Venus will emanate from the top of its dense atmosphere, which is at a temperature of 154°F. The IR from nearly airless Mars will be coming from its surface, which is at 45°F at the equator, –90°F at the poles.

Because of the low temperatures of the emitting surfaces, the IR available for navigation will be at the long wavelengths. However, most detectors sensitive to these wavelengths require cooling by bulky liquid gas systems and therefore are not suited for a compact space vehicle installation, says Banres' vp and technical director Eric M. Wormser. He claims that this is the reason that thermistor bolometer detectors, which are sensitive to long wavelengths without the need for cooling, were selected for *Mariner* missions.

• **How to find a planet**—At about 100,000 miles from either Venus or Mars, the IR sensor is ready to take control of the probe. Its first task is to find the planet. To do this, the sensor uses a pair of counter-rotating wedges, one turning at about 300 rpm, the other at about 100 rpm. These "see" an instantaneous field of view of ½° by ½° whose locus is a rosette-shaped




*SCHA OF INFRARED SYSTEM to be used to orient Venus/Mars fly-bys to keep their instruments facing the planets.*

pattern 70° in diameter.

For the probe to be effective, previous guidance and attitude control must have oriented the spacecraft so that the target planet falls within the 70° field of view of the IR sensor system.

While the rosette is being generated, the pattern is being rotated about 5 rpm until the target is found. Then the acquisition motor stops. At the same time, the IR radiations picked up begin generating electrical voltages in the detector. By measuring the duration and timing of these voltages, the system develops error signals corresponding to each leaf in the rosette. When these errors are made equal to each other—by suitable orientation of the probe—the target is at the rosette's center.

• **Inside the bolometer**—The heart of the system is the thermistor bolometer. It is well known that thermistors are thermally sensitive resistors which show large changes in resistance with changes in temperature. Therefore, the devices can be used as IR radiation detectors. When they are, they are made in small and very thin flakes. For fast response to changes in radiation, the flakes are solidly backed by heat sinks of high thermal conductivity.

In Barnes thermistor bolometers, closely-matched pairs of these flakes are mounted in small cylindrical capsules. The "active" or receiver flake, which is to be exposed to the IR, is centrally and precisely located with respect to the capsule's outer diameter. The "compensating" flake is located off-center and is shielded from IR.

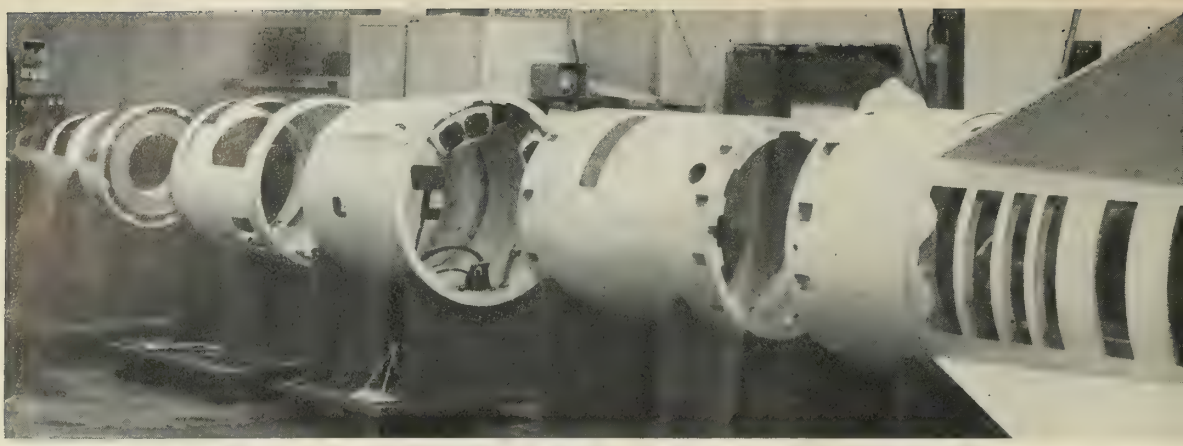
The bolometer is usually operated in a bridge circuit, with the two flakes equally and oppositely biased. The output terminal, which is the junction of the two flakes, is thus maintained near ground potential to reduce noise and microphonics. Since the two flakes are closely matched, the drift of the output terminal with changes in ambient temperature is made negligible.

When the bolometer is exposed to IR, the active flake is heated, its tem-

*(Continued on page 40)*

## Properties of Mars and Venus Relevant to Their Infrared Detection

| PROPERTY | MARS | VENUS |
|---|---|---|
| DIST. FROM SUN (EARTH = 1) | 1.524 | 0.723 |
| TEMP. (°K) | 280 (equator)<br>205 (pole) | 430 (surf.)<br>225 (top of atmos.) |
| TOTAL RADIANT ENERGY EMITTED (watts/cm²-steradian) | 0.011 (equator)<br>0.0032 (pole) | 0.063 (surf.)<br>0.0046 (top of atmos.) |
| PEAK WAVE LENGTH OF RADIANT ENERGY EMITTED (microns) | 10 (equator)<br>14 (pole) | 7 (surf.)<br>11.5 (top of atmos.) |



# First Photos of Nike-Zeus Assembly

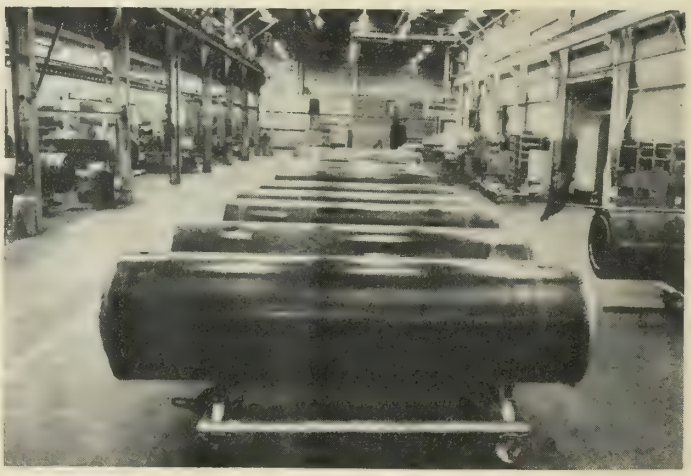
ARMY's *Nike-Zeus* anti-missile missile takes shape at White Sands Missile Range, N.M., prior to a recent R&D test firing.

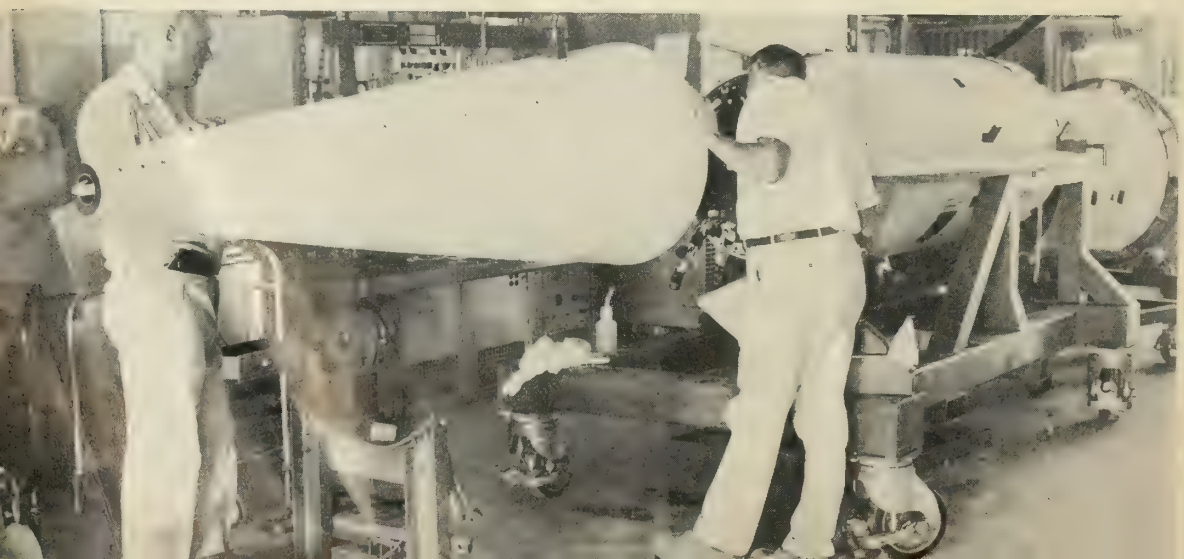
Photo above shows a mockup of the warhead and sustainer sections of the bird, a product of a combined Army-Industry team with Western Electric Corp. the prime contractor and Douglas Aircraft Co. the subcontractor and responsible for motor cases.

At right, booster and sustainer motor cases await assembly.

Below, technicians in the Missile Assembly Building join component parts of the *Nike-Zeus*. Each section of the Free World's only anti-ICBM weapon is handled separately and joined just before firing.

The newest and largest of the Western Electric *Nike* family has been undergoing intensive developmental firings at White Sands and has completed its first successful guided flight. It will soon be tested against ICBM's over Pacific Missile Range.





## Atlas-based Shot Failures Worry NASA Planners

CAPE CANAVERAL—Reliability of *Atlas*-based launch vehicles is causing great concern among officials of the National Aeronautics and Space Administration.

A measure of the magnitude of the situation is given by the fact that NASA plans to launch at least 35 *Atlas*-based vehicles in the next three years, a program whose cost will approach a half-billion dollars.

But even more than money is at stake. America's astronauts are scheduled to make their orbital flights with the aid of *Atlas* launchers.

So far, NASA's record with *Atlas*-based vehicles is 0 for 6. Four of the six were used in the now-defunct *Atlas-Able* moon orbit program and two were tests for Project *Mercury*.

The Air Force's record with *Atlas*-based space probes is little better—1 for 3.

• **Cost of complexity**—No one is pointing the finger at *Atlas* alone, which has a record of 47 successes, 11 partial successes and 16 failures in 74 military test launchings. The question raised in some quarters, rather, is whether putting upper stages or complex payloads on the already complex *Atlas* system increases the intricacy to such a degree that reliability is almost impossible.

At a briefing following the explosion of the *Atlas-Able* lunar probe vehicle after 70 seconds of powered flight Dec. 15, spokesmen for NASA, Space Technology Laboratories and the AF Ballistic Missile Division affirmed their faith in the design of the 3½-stage vehicle.

Lawrence I. Hogarth of NASA's Goddard Space Flight Center, Adolf Thiel of STL and Maj. Edward Darcy of BMD voiced disappointment that none of the four vehicles in the program succeeded in putting the 388-lb. spacecraft into an escape trajectory so as to test the technique for injecting it into an orbit about the moon.

Hogarth said that, so far as he knew then, there was no intention to fire another similar shot. It would take from 9 to 12 months to do so if such a decision were made, he added.

The lead time required for another vehicle means that it could not be available before NASA begins testing the *Ranger* aboard *Atlas Agena B* launch vehicles. But Hogarth said there were no present plans for putting the *Atlas-Able* spacecraft's hydrazine engine and mid-course and terminal guidance gear aboard *Atlas-Agena B* launch vehicles.

Following the Dec. 15 explosion, NASA began a lengthy investigation into the cause, saying only, "it appears that a malfunction occurred in the launch vehicle." ⌗

# The Missile/Space Week

### Mercury Cost Expected to Hit $500 Million

The House Space Committee Staff is forecasting that the pricetag for NASA's Project *Mercury* may well exceed a half-billion dollars before the program ends. That would put the cost of *Mercury* at about 150% more than originally estimated when the program was initiated in 1958.

The committee staff said in a preliminary *Mercury* progress report that it based the possible half-billion dollar cost on the expectation that *Mercury* would not hold to its much readjusted schedule. The staff said the program would cost $393 million if it meets all of its present flight test target dates.

Despite the rising cost of the program, the staff report said *Mercury* is "progressing satisfactorily." As for statements by critics that *Mercury* is being overtaken by advancing technology, the report said there is "no categorical indication that such is the case."

### The Pentagon Lineup Takes Shape

An old Pentagon hand and a politically savvy attorney will be taking over direction of the Air Force and Navy respectively this month.

President-elect Kennedy this last week added to his principal Pentagon nominations:

–Eugene Zuckert, a 49-year-old Washington lawyer, as Secretary of the Air Force. He formerly was an Assistant Air Force Secretary during the Truman Administration and a member of the AEC.

–John B. Connally, a 43-year-old Ft. Worth lawyer, and ex-Naval officer as Secretary of the Navy. He formerly was Vice President-elect Lyndon Johnson's administrative assistant and served as Johnson's campaign manager during the drive to make him the presidential nominee last year.

Zuckert is considered an experienced government official who knows his way around Washington. Connally is considered to be sharp-minded and a political fighter.

### Air Force Missile Defense Work Grows

Expanding Air Force activity in the missile defense field received another boost this last week with a $147,803 contract to Douglas Aircraft.

The contract—let under an ARPA project delegated to the Air Force—is for a three-month study of the exhaust heat trails of missiles launched from Cape Canaveral. Aerojet-General is a subcontractor for the project.

The study will be made with electronic monitoring equipment carried aboard an Air Force B-50. The operational ceiling of a B-50 is about 35,000 to 40,000 feet.

### Army Drone Cancellation Consolidates Programs

The Army is consolidating its surveillance drone programs with the sudden cancellation of its contract with Republic Aviation for development of the *SD-4* combat surveillance drone. Components of the *SD-4* system such as airborne guidance units and radar equipment will be used in other Army surveillance projects.

However, the cancellation clearly indicated that the economy squeeze rather than consolidation was the principal reason for the move. The Army had spent $34 million on the project so far. The first *SD-4* flight was scheduled for next month. The program represented about one percent of Republic's backlog.

### New Soviet Missiles Cover Red China

The Russians are reported to be building a new chain of Asian bases for 3000-mile range missiles. (M/R, Feb. 15, 1960.)

The bases—reported by the Italian News Agency Continental—to be under construction on the Kamchatka Peninsula—could be used for peppering missiles on Red China, Japan and Alaska.

The news agency also reported that the Russians have completed 22 missile bases on the Kola Peninsula near the Finnish border and have under construction another group around Lake Baikal near the Mongolian border.

# Weather Satellite System Weighed

***New Administration will decide whether to invest in Tiros-type or wait until '63 for improved Nimbus***

A PLAN FOR an operational weather satellite system, to be set up in addition to the *Tiros-Nimbus-Aeros* series of research satellites, is being prepared for submission to the Kennedy administration.

The National Aeronautics and Space Administration, the Weather Bureau, the Department of Defense and possibly the Federal Aviation Agency plan to begin discussions soon on the system, which presumably would be operated by the Weather Bureau.

The major question to be decided by the joint committee is whether to go ahead now with *Tiros*-type satellites or to wait for *Nimbus*, which probably will not be available for operational use before 1963.

Dr. Morris Tepper, NASA chief of meteorological satellites, has prepared a 45-page memo outlining problems that will have to be settled before any decision is made to go ahead with an operational program.

The decision to begin an interagency study of the problems was made at a high-level meeting in October. The work apparently was speeded after the successful launching of *Tiros II*. Top agency officials agreed Nov. 26, two days after the launching, that the Weather Bureau would control operational use of weather satellite data.

Tepper emphasized in an interview that the number of problems to be solved made it impossible to predict how long the study would take. He declined even to predict whether committee recommendations would be ready for submission to Congress during its 1961 session.

• **Range of problems**—The NASA meteorologist said problems fall in five major areas—requirements, elements of the system, operational factors, scheduling and management.

Under requirements, the major question is whether the user agencies—the Weather Bureau and military weather services—will be satisfied with the performance possible in the spinning *Tiros* satellites. *Tiros* pictures must be "rectified" by a complex process because they are taken at an oblique angle, rather than from a vertical position (M/R, Dec. 5, p. 15). The *Nimbus* satellite, which will begin flight tests late in 1962, will be stabilized so that its lenses and instrumentation point permanently toward the earth.

Once the requirements are established, the need is to set up a system—the satellites in flight, launch vehicles, facilities for receiving and converting data and communications links to weather information channels.

Operational factors cover the questions of how elements of the system fit together.

Scheduling covers availability of vehicles, spacecraft and pad and range time.

Finally, under management, are the questions of who runs what. All that is decided to date is that a civilian user agency—either the Weather Bureau or a special weather satellite agency—will have charge of use of the data. Who will have charge of design of spacecraft and launchings is up in the air.

• **Add one Tiros**—Regardless of what kind of operational satellite program is chosen, Tepper said, NASA will pursue a vigorous R&D program. For the immediate future, NASA is considering the possibility of adding one *Tiros* to the 1961 schedule.

A spacecraft launch vehicle, which had been tentatively scheduled for January as a backup for *Tiros II*, could be used for the purpose. Tepper said the most likely possibility is a *Tiros* launch during the spring, to obtain data on spring storms, and the fourth *Tiros* as previously scheduled later in the year.

• **Outlook for Nimbus**—The first *Nimbus* will be launched some time in 1962, Tepper said. Apparently, his statement represented some slippage from the previous target of the second quarter of that year.

NASA's Goddard Space Flight Center held an industry briefing Nov. 28 on the prime contract for the spacecraft. Bids were due Dec. 28 and Tepper said he hopes to award a contract before March 1. The contract will call for delivery of a prototype and three flight model satellites, which will cover the first two launches.

Later, there will be two flights of an advanced *Nimbus* with more sophisticated instrumentation. All *Nimbuses* will be launched down the Pacific Missile Range into 80° retrograde orbits.

The first two will carry improved television cameras for daytime cloud observation, infrared sensors to make nighttime observations and measuring total heat balance, and solar observations of importance to meteorology.

*Nimbus* 3 and 4 may carry radar and infrared spectrometers. A third possibility is some sort of device for on-board analysis of satellite observations, to help reduce the flood of data sent to ground stations. ⌗

## Report Urges Studies of Space Impact

EXHAUSTIVE investigation of the impact of space activities on mankind is recommended in a Brookings Institution report to the National Aeronautics and Space Administration.

Working under a $96,000 NASA grant, the Brookings group suggested in a 190-page report that NASA establish an in-house staff of social scientists to supervise studies contracted with outside groups of the implications of such subjects as weather satellites, communications satellites and the impact of operations in space on industry, government organization, foreign policy and the availability of scientific and technical manpower.

Donald N. Michael, who headed the eight-man Brookings group, said the study was authorized by NASA under the provision of the 1958 Space Act requiring the government to establish "long-range studies of the potential benefits to be gained from the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes." The study was merely to point out problem areas, not solutions. The Brookings group produced 190 pages of problems.

Although the report recommended that the studies be carried out by NASA, Michael said, they might just as well be performed by another agency of the government.

The Brookings report was issued a week before President-elect Kennedy announced that Vice President-elect Johnson will head the National Aeronautics and Space Council, a top-level

*(Continued on page 40)*

# How to Make Man Efficient in Space?



*ARTIST'S CONCEPTION of a re-entry configuration which the Martin Co. has been studying. The shape may figure in the design of Apollo or Slomar.*

**by Heather M. David**

THE BIGGEST PROBLEM in manned spaceflight in the 1965-75 era may not be keeping man alive but keeping him functioning at peak efficiency.

Dr. M. A. Grodsky, head of the Life Sciences section of The Martin Co.'s advance systems and advance systems research department, said that Martin was not particularly worried about the life support aspects of future space travel.

"I am fully confident that by 1965 many of the physiological problems will be understood and the necessary equipment can be built. We are concerned about maintaining the space traveler's high performance."

Martin has launched a battery of studies along several different lines from which it hopes to learn how to get optimum human performance. Two of the current contracts to which these studies will be applied are *Apollo* and *Slomar*.

Under the six-month *Apollo* study contract awarded to Martin by the National Aeronautics and Space Administration, the company is to investigate the feasibility of a three-man spaceship capable of circumlunar missions lasting about 14 days. Convair and General Electric MSVD received like contracts.

Besides the basic propulsion, navigation and re-entry problems, Martin is putting emphasis on the relationship between man and machine and man to man. Some 15 researchers with degrees in psychology, mathematics, physiology, biochemistry, engineering and neurology daily attack problems which will face man in the 1965-1975 period. "There will be no time for errors when we get into space," is the general theory.

• **Vehicle control**—The preliminary concept of *Apollo* is that the ship will be compartmentalized into three sections. The command center will be used by the pressure-suited and strapped down astronauts during launch and re-entry. The propulsion center would be used in case of an aborted mission for return to earth.

The crew work area, in which most of the trip will be spent, is the main concern of the Life Sciences group.

The Martin Co. has constructed a full-size mockup of a crew work center in which it will run extensive tests to develop the best methods of presenting information. With it the researchers will try to discover what kind of information is most useful to the crew and causes no confusion.

Another problem the group is attacking is how accurate or clear this information must be.

With a simple projector type machine which flashes geometric shapes at different degrees of resolution, the Life Sciences group has found that humans can perceive what they need to know at resolutions far lower than previously thought. This research they hope, may lead to savings in cost and power.

Four full-time "subjects" are employed by the Life Sciences group to do nothing but take perception and "vigilance" tests all day. Members of the Martin staff, including pilots and engineers, are available to the group for testing which requires more trained subjects.

• **Length of work periods**—Dr. Grodsky's group has been doing considerable research in the area of vigilance, or ability of the subject to perform effectively over long periods of time.

Many studies have indicated that man's ability to make correct decisions slips more and more the longer he is tested. It appears from these tests that he could not perform effectively for a very long time.

The Martin group is delving into the problem a little further with the idea that perhaps the subjects were not tiring, but changing their criteria for making decisions—getting more lax as time wore on. The data the Baltimore group is coming up with indicates that humans can be trained to work long periods of time and still give good performance.

• **Psychological sensors**—Isolation and confinement on trips such as *Apollo* will not be the problems many think they will, according to Martin's conception. There will be enough real tasks in space to keep the astronauts well and busy.

It will probably be necessary to have some artificial task to monitor pilots' psychological condition. There are hundreds of possible tests, says Dr. Grodsky, but the question is finding the right one or ones.

Tests on animals are worthless on humans. And in addition, the researchers would like to be able to predict what the man's condition will be a given time after the test.

• **Radiation**—The advanced systems group is also planning a study on the amount of permissible radiation for man. Martin's group hopes to show that, with some risk, space travelers may be able to tolerate far greater exposure than previously estimated.

The group is basing its study on clinical data being collected by Dr. W. Loomy of Johns Hopkins and on data released from Japan.

Next step in this study will be to start animal studies. The animals used in the radiation experiments will also be subjects for disorientation studies. Later in the year the Life Sciences department expects to get a surgical laboratory where it will experiment with labyrinthectomized animals, or animals with their inner ears surgically removed.

• **Food acceptability**—Nutrition almost has become a problem for the psychologist in planning for space travel. The Life Sciences section plans to do some very complete studies on the relatively acceptable levels of different foods, from algae on up. ⌘

# Chimp to Go in Next Flight Test Of Mercury

*Given all possible breaks, U.S. might be able to get an astronaut into space in early March*

**by Jay Holmes**

CAPE CANAVERAL—A chimpanzee will ride in the next *Mercury Redstone* ballistic flight, probably late this month. This would put the shot some 15 months later than originally planned.

The test, designated MR-2, will be the first flight test of the man-in-space capsule's life support system. If the shot succeeds, the next *Mercury Redstone* (MR-3), will carry an astronaut.

The timing of the MR-3 flight—on a 4200 mph ballistic trajectory that will mark America's first manned space flight—is subject to all of the variables possible in a research and development program. With a streak of perfect luck in the next 60 days, Project *Mercury* might be able to fly a man by early March. A more realistic date, however, is mid-April.

If America beats Russia in the launching and safe return of a man from ballistic flight in space at 125 miles altitude, one result would of course be an important psychological victory. But it would be only a step, although an important one, toward accomplishing the prime objective of Project *Mercury*, manned orbital flight.

U.S. officials still say they expect to orbit a man in 1961, but most dispassionate observers agree that the orbital shot seems bound to slip into 1962. Thus Russia, despite the recent failure of her prototype space ship to return from orbit, still is the odds-on favorite to put a man or men in orbit first.

• **Light dimly seen**—Nevertheless, managers of the trouble-plagued man-in-space program are beginning to voice cautious optimism that at least one phase of their troubles is behind them.

"All of our missile programs had troubles at the start," said Walter C. Williams, chunky chief of operations for the National Aeronautics and Space Administration project. He referred obviously to the months of slippage that preceded the first successful launch of a capsule by a *Redstone* on Dec. 19 and to the continuing delay following the disastrous first *Mercury Atlas* shot last July.

"We have had our share of problems," Williams told MISSILES AND ROCKETS. "But now we have capsules coming out of McDonnell at a pretty good rate. We are getting repeatability. The next job we have is to learn to fly them well."

Besides MR-1, which was returned to the McDonnell plant at St. Louis for thorough examination, four production capsules have been at the Cape for at least three weeks. They are: Capsule 5, assigned to MR-2; Capsule 6, assigned to MA-2; Capsule 7, assigned to MR-3, the first manned flight, and Capsule 8, assigned to MA-3.

• **Flight record**—Four production versions of the capsule now have flown. Capsule 1 flew in a test of the escape tower at Wallops Island, Va., last May 9. Capsule 4 was carried on the MA-1 test in which the *Atlas* exploded July 29. Capsule 3 flew in the *Little Joe* test at Wallops Island Nov. 8.

Capsule 2 flew on the Dec. 21 MR-1 flight, which *Mercury* director Robert R. Gilruth described as an "unqualified success." It reached an altitude of 135 statute miles and traveled 235 miles downrange.

After the 11:15 a. m. launch, events followed this staccato timetable: Landing at sea, 11:31 a. m.; recovery by a Marine helicopter, 11:46 a. m.; delivery to the carrier Valley Forge deck, 12:03 p. m.

The only apparent damage was a slight searing of the paint on the hull and a broken window pane on one port. Each window has three or four panes. Thus the breaking of one port on impact would not have created any problem if an astronaut had been inside.

• **Blinker inadequate**—When the capsule was flown to the Cape, about 20 hours after launch, internal batteries were still powering equipment aboard, including a clock inside and a blinking white light at the top of the bell, de-



*ABOARD USS Valley Forge the MR-1 Project Mercury spacecraft is washed down and prepared for return to Cape Canaveral after Dec. 19 launching.*

signed to aid in recovery operations.

One change indicated by the test is a bigger blinker. Lt. Wayne Koons, pilot of the helicopter, said he and his crew did not see the light against the glare of the bright noonday sun reflected from the sea. The Marines spotted the capsule with the aid of smoke.

• **Booster change**—MR-1 succeeded on its third attempt. The shot was scrubbed Nov. 7 when a valve in the capsule's reaction control peroxide jet system was found to be not functioning properly 22 minutes before launch time. Two weeks later, the booster ignited, burned for a few milliseconds and shut down. The cutoff signal then actuated the escape rocket jettison tower and carried it away just as should have happened on a shutdown at 35 miles altitude, at the conclusion of normal burning. Then the capsule's parachutes were deployed, also as programed, when their controls sense thick atmosphere after jettisoning of the escape tower.

The premature engine cutoff was traced to a plug that grounds the booster electrically, which had disengaged a fraction of a second too soon. The problem was solved by making the ground connection cable several inches longer to make certain it disengages last in sequence with other pad-to-booster connections.

The booster used in the Nov. 21 attempt lifted an inch or so from the pad and then settled back, damaging the tail section slightly. As a result, a new booster was used. No. 2 capsule was used again, however, refitted with an escape tower and parachutes.

Williams noted that the booster and capsule "saw each other" for less than two weeks before the successful flight.

One other change in the MR-1 system grew out of the Nov. 21 experience. A timer device was interposed between the engine and the escape tower jettison rockets to prevent an engine cutoff signal getting through to the tower until the booster neared the end of its normal burning time. The circuitry, however, is set up so that a command from the ground will fire the escape rockets and pull the capsule free of the booster in case of booster malfunction.

• **Willing astronaut**—Williams, who sits in the operation control "slot" on all *Mercury* launches, said high winds at 60 miles altitude caused the capsule to travel 15 miles farther downrange than the 220 miles programed. He added that the deviation was within tolerances.

The reaction jets worked well in positioning the capsule for re-entry, Williams said, and the maximum deceleration was 10 g, instead of the expected 11 g.

Navy Lt. M. Scott Carpenter, the astronaut assigned to the communication console during the test, said he did not observe any situation that would have required him to assume control, had he been aboard. He replied in the affirmative when asked whether he would have liked to be aboard.

The capsule fittings, however, did not include the life support system and an astronaut's couch. In their place were a 16-mm camera, installed to the left of where the pilot's head would be, recording the functions of the cockpit instrument display panel, as well as extra instrument boxes and ballast weights.

• **Teams of apes**—Eight animals are in "training" at Holloman AFB, N.M., for the chimpanzee mission. The simians, averaging 60 lbs. in weight and 50 in. tall, have been separated into groups of four to prevent spread of any disease they might develop.

Both groups have spent some time at Cape Canaveral for training in an altitude simulator fitted with the production version of the capsule environmental control system. They have been returned to Holloman but all will move to the Cape again for selection for the flight.

• **Severe test conditions**—The next *Mercury Atlas* shot, Williams said, will be largely a repeat of MA-1, to qualify the capsule by putting it to a mission abort during powered *Atlas* flight. The suborbital ballistic profile of the flight calls for a re-entry that will subject the capsule afterbody to extremely high temperatures and high air-load conditions—far more severe than those the capsule would encounter after a normal orbital flight.

The program calls for boosting the capsule to an altitude of 110 miles and a speed of about 13,000 statute mph. and landing it 1500 miles downrange about 20 minutes after launch. On re-entering at 50 miles altitude, the nickel alloy afterbody shingles will heat up to about 1500°F and the blunt face of the ablation heat shield is likely to go up to 3000°F.

The capsule body, in such a re-entry, would be subjected to deceleration of up to 16 g, twice the g load encountered in re-entering after a normal orbital mission. The heavy g load is due primarily to the sharp re-entry angle programed, four to five times the normal re-entry angle of about 2°.

The operations chief declared that MA-2 will provide much more of a system test than would have been possible with MA-1, a capsule shell pulled out of the production line for an early check of the structure.

In the new test, the capsule will carry many of the internal capsule systems—not only the shell. Williams said that, if the booster performs properly, the next shot will carry out the tests programed originally for both MA-1 and MA-2.

• **Second phase**—After completion of the *Atlas* ballistic tests, the next phase of the *Atlas* program calls for firing of capsules in orbit without occupants, capsules in orbit with chimpanzees and, finally, manned orbital capsules. Williams declined to say just when the second phase would begin. However, NASA sources indicated last summer that MA-4 would be the first orbital capsule flight if the first three accomplish their objectives.

Despite the long delay between MA-1 and MA-2, Williams insisted NASA still expects to put a man into orbit by the end of 1961. Nevertheless, he noted that each successive step must depend on the success of previous steps in a complex R&D program—a situation subject to slippage at any step of the way.

• **Atlas is "it"**—Williams said he is not overly concerned with *Atlas* reliability. When *Atlas* was chosen as a launch vehicle, he declared, it was predicted that the vehicle would be highly reliable by the time it was needed for manned flight. He still believes the prediction will hold true.

But it will never be 100% reliable, the *Mercury* official added, "and there is nothing we can do about it."

"We have covered ourselves," he continued, "with the capsule escape system. Our problem boils down to providing the escape system and reaching our test objectives."

Regardless of the reason, Williams continued, "we could not redesign or rebuild the *Atlas*."

On the ill-fated MA-1 launch, he declared, "there is no question that an active escape system would have saved the capsule. It was intact when it hit the water," even though still attached to parts of the *Atlas* that exploded.

On the MA-1 test, as on last month's MR-1, the abort sensing system was on open loop. Its temperature sensing and other devices gave the signal that would have actuated the escape rockets. However, on *Little Joe* 5, launched from Wallops Island Nov. 8, the escape rockets failed to separate the capsule from the booster as programed at 35,000 ft. ⌘

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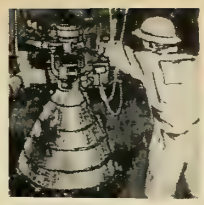


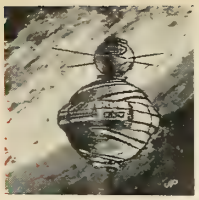
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JANUARY, 1961

# MISSILES and ROCKETS

# ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



## Satellites and Spacecraft

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**ADVENT** (Army) | Army Signal Corps, prime; GE-Bendix prime for polar-orbiting phase; Bendix prime for 24-hour satellite | Twenty-four hour instantaneous repeater communications satellite; 1000 lbs.; program incorporates Projects STEER and DECREE | R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed |
| ★**ANNA** (Army, Navy, AF, NASA) | No contractors announced | Geodetic satellite; 50-100 lbs.; probably spherical | Study completed; R&D program appears imminent |
| **AEROS** (NASA) | No contract announced | 24-hour weather satellite to be boosted by CENTAUR or SATURN | Planning. First flights would be in 1964 or 1965 |
| **APOLLO** (NASA) | Convair, Martin, GE | Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN | Six-month studies in progress; R&D prime to be chosen in FY '62 |
| ★**ARENTS** (ARPA) | Convair, prime | Satellites to investigate deep space; 22,000 m. orbits | Contract let to build three payloads |
| ★**ASP** (Air Force) | No contracts announced | Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space | Study |
| ★**BAMBI** (ARPA) | No contracts announced | Satellite system capable of intercepting enemy satellites | Studies |
| **COURIER** (Army) | Army Signal Corps, prime; Philco, payload; Radiation, Inc., antennas; ITT, ground stations | Delayed repeater communications satellite; 51 in. diameter, 500 lbs. | COURIER 1A launching failed in August because of booster blow-up. COURIER 1B placed in orbit, transmitted messages and p[illegible] |
| ★**CSAR** (Air Force) | No contracts announced | Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors | Studies; possibly operati[illegible]-60's |
| ★**DISCOVERER** (Air Force) | Lockheed, prime; GE, re-entry vehicle | THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems | Launchings: 19; c[illegible]s recovered from orbit and air snatched; after orbiting earth [illegible] to three days; simians to be p[illegible]n capsules in 1961 |
| ★**DYNA-SOAR I** (Air Force) | Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link | Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN I booster; TITAN II probably to be used later | R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway; R&D space flight ab[illegible]/66 |
| ★**ECHO** (NASA) | Langley Research Center, prime | Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite; next model more rigid | Second [illegible]unching attempt successful Aug. 12; next shot this year |

★ Indicates change since November, 1960 Astrolog

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**MARINER** (NASA) | JPL, prime | 600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B | Seven shots planned. First scheduled Venus fly-by 1962 third quarter |
| ★**MERCURY** (NASA) | NASA, prime; McDonnell, capsule | First manned satellite; 1 ton capsule boosted by ATLAS | Program continues to slip. First manned capsule launching by REDSTONE now scheduled this spring. First manned orbit shot expected late 1961 or early 1962. |
| ★**MIDAS** (Air Force) | Lockheed, prime | Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites | R&D; second launching May 24 partial success; components being tested by DISCOVERER |
| **NIMBUS** (NASA) | No contracts announced beyond minor subsystems | 2nd generation weather satellite; THOR-AGENA B booster | First launching scheduled for early 1962, but procurement delay makes date doubtful |
| **OAO** (NASA) | Grumman, prime; Westinghouse, electronic components | 3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B | First flight scheduled in late 1963 |
| ★**OGO** (NASA) | Space Technology Laboratories, prime | 1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters | First flight scheduled in 1963 |
| ★**OSO** (NASA) | Ball Brothers, prime | 350 lb. orbiting solar observatory; THOR-DELTA booster | First flight planned early in 1961 |
| **PROSPECTOR** (NASA) | No contract announced | Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster | First flight planned by 1965; study contracts to be awarded in 1961 |
| ★**RANGER** (NASA) | JPL, prime; Aeronutronic, capsule; Hercules, retrorocket | 300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster | R&D; first flight planned 1961; first lunar landing planned for 1962, instrumentation to include seismometer |
| **REBOUND** (NASA) | No contract announced | System of 12 or more multi-launched passive communications satellites | Study |
| ★**SAINT** (Air Force) | RCA, prime | Anti-satellite satellite inspection system; to be complemented by interception system; ATLAS launched | R&D underway |
| ★**SAMOS** (Air Force) | Lockheed, prime | Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. | R&D; first launch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program; components being tested in DISCOVERERS |
| ★**SLOMAR** (Air Force) | Lockheed and Martin, prime | Logistics, maintenance, supply spacecraft for space systems | Study contracts awarded in December |
| **SURVEYOR** (NASA) | No contract announced; STL, McDonnell, North American, Hughes competing | Soft-landing 100-300 lbs. instrumented spacecraft on moon; ATLAS-CENTAUR booster | Competing studies completed; R&D contract to be awarded early 1961; first moon flights '63-'64 |
| ★**TIROS** (NASA-AF-Army-Navy-Wea. Bu.) | RCA-Army Signal Corps, prime | Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner | R&D; first launching in April; second Nov. 23, both successful. At least one more planned |
| ★**TRANSIT** (Navy) | Applied Physics Laboratory, prime | Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs. | TRANSIT IB R&D satellite in orbit April 13; IIA plus piggyback satellite in orbit June 22, four-satellite TRANSIT system scheduled operational 1962; TRANSIT IIIA launching failed Nov. 30 due to booster |
| **VOYAGER** (NASA) | No contract announced | Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster | Study; first flight planned by 1965 |
| **YO YO** (Navy) | No contract announced | Tactical sea-launched one-pass reconnaissance satelloid | R&D |
| ★**X-15** (NASA-AF-Navy) | North American, prime; Thiokol, propulsion | Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered. | Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 undergoing flight tests with XLR-99 engine; NASA to get soon |



# Missiles and Rockets

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**ALFA** (Navy) | Navy, prime; Avco, air frame | ASW surface-to-underwater; 500 lb. solid; conventional | Deployed on destroyer escorts |
| **ASROC** (Navy) | Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H | Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved torpedo) under R&D | R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers |
| **ASTOR** (Navy) | Westinghouse, prime | ASW underwater to underwater rocket torpedo; nuclear | R&D |
| ★**ATLAS** (Air Force) | Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle | ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial | 74 launchings; 47 successes, 11 partial, 16 failures; 11 bases for 13 squadrons; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 12 launchers operational—40 to 60 expected in 1961 |
| ★**ARM** (Air Force) | No contract announced | Anti-radar missile air to surface | Studies; plan for separate missile shelved at least temporarily |
| **BOMARC-A** (Air Force) | Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion | Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear | First squadron operational at McGuire AFB, N.J. |
| ★**BOMARC-B** (Air Force) | Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion | Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear | B models being produced; a B test bird intercepted simulated target 345 miles away Oct. 14; R&D launchings: 18; 10 successes; 8 failures |
| **BULLPUP** (Navy-Air Force) | Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion | Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear) | Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters |
| **COBRA** (Navy) | No contract announced | Anti-ship radar missile | Early R&D |
| **COBRA** (Marines) | Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor | 20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant | Marines planning to purchase; Army considering them; already operational with West German troops |
| **CORPORAL** (Army) | Firestone, prime; Gilfillan, guidance; Ryan, propulsion | Surface-to-surface; 75-mile range; liquid; nuclear | Deployed with U.S. & NATO troops in Europe |
| **CLAYMORE** (Army) | No contract announced | Anti-personnel missile | R&D |
| **CROW** (Navy) | No contract announced | Air-to-air missile | R&D; has been flight tested |
| ★**DAVY CROCKETT** (Army) | In-house project at Rock Island, Ill., arsenal | Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men | R&D; operational this year; first NATO deliveries also this year |
| **EAGLE** (Navy) | Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe | Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs.; Mach 4; solid | R&D; Missileer production run reported to be 120 in next [illegible] years |
| ★**FABMIDS** (Army) | Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies | Mobile anti-missile defense system | Each of six contrac[illegible]ave $250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61 |
| ★**FALCON** (Air Force) | Hughes, prime; Hughes, guidance; Thiokol, propulsion | Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead | GAR-1 thro[illegible]GAR-4 operational; GAR-9 R&D [illegible]AR-11 operational in near futur[illegible] |
| **GENIE** (Air Force) | Douglas, prime; Aerojet-General propulsion | Air-to-air; unguided; 1.5-mile range; nuclear | Operati[illegible] |
| **GIMLET** (Navy) | No contract announced | Air-to-surface; unguided; considered highly accurate | R&D |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **HAWK** (Army) | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion | Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes | Operational; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29 successfully intercepted HONEST JOHN, first known missile intercept of another |
| **HONEST JOHN** (Army) | Douglas/Emerson Electric, prime; Hercules, propulsion | Surface-to-surface; unguided; 12-mile range; nuclear | Operational; deployed in Europe |
| **HOUND DOG** (Air Force) | North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion | Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear | Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400 |
| ★**JUPITER** (Army) | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle | IRBM; liquid; nuclear; can be made mobile | To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape |
| **LACROSSE** (Army) | Martin, prime; Martin, guidance; Thiokol, propulsion | Surface-to-surface; highly mobile; 20-mile range; solid; nuclear | Operational; 4 units being trained; 3 more planned for 1960; being deployed in Europe and Far East; advanced LACROSSE R&D dropped |
| **LAW** (Army) | No contracts announced | Light antitank missile to be carried in tube | R&D under AOMC |
| **LITTLE JOHN** (Army) | Emerson Electric, prime; ABL, propulsion | Surface-to-surface; unguided; 10-mile range; solid; nuclear | Operational this year; units training with it |
| **LOBBER** (Army) | No contract announced | Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA | Studies |
| **LULU** (Navy) | General Mills/Naval Ordnance Lab, prime | Small nuclear depth charge air-dropped or launched by ASROC | Operational |
| **MACE** (Air Force) | Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has more than 1200 m. range | Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; first hard-site launch July 1960 |
| **MATADOR** (Air Force) | Martin, prime; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; 650-mile range | Being turned over to West Germans; also deployed in Far East |
| **MAULER** (Army) | Convair, prime | Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher | R&D; NATO may buy |
| ★**MINUTEMAN** (Air Force) | Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher | 2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages | R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape scheduled imminently; tactical rail system tests completed; first 3 squadrons at Malmstrom; Ellsworth AFB, S.D., being surveyed for more |
| **M-55** (Army) | Norris Thermador, prime | Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers | Operational |
| **MISSILE A** (Army) | ARGMA prime | Surface-to-surface; 10-20 mile range; solid | Design studies |
| ★**NIKE-AJAX** (Army) | Western Electric, prime; Western Electric, guidance; Thiokol propulsion | Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional | Deployed in U.S., Europe & Far East; about 170 batteries in U.S. sixty-eight more to be phased out and replaced with NIKE-HERCULES |
| ★**NIKE-HERCULES** (Army) | Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion | Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed | Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; NIKE-HERCULES units on Formosa |
| ★**NIKE-ZEUS** (Army) | Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion | Anti-missile; 3-stage; 200-mile range; solid; nuclear | R&D test launchings at White Sands, 12 R&D launchings; 7 successful, 3 partial, 2 failures. Complete system tests now scheduled for mid-'62 |
| ★**PERSHING** (Army) | Martin, prime; Bendix, guidance; Thiokol, propulsion | Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on tracked FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range | R&D; to replace REDSTONE; 9 R&D launchings: 8 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 1 failure. Operational late 1961 |

| | | | |
|---|---|---|---|
| ★**POLARIS** (Navy) | Lockheed, prime; GE, MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle | Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D | 85 launchings of test vehicles; 60 successes; 21 partial; 4 failures; 13 also launched from submerged subs —all cleared surface; 9 successful flights, 4 failures. First sub with 16 missiles deployed in November |
| ★**QUAIL** (Air Force) | McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment | ECM-carrying bomber decoy; about 200 m. range; jet powered | Deployed at SAC bases; carried by B-52 |
| **RAVEN** (Navy) | No contract announced | Air-to-surface; about 500-mile range | Study |
| **REDEYE** (Army) | Convair, prime; Philco/Convair Atlantic Research, propulsion | Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable | R&D; Marines also will use; NATO may buy |
| **REDSTONE** (Army) | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion | Surface-to-surface; liquid; 200-mile range; nuclear | Deployed with U.S. troops in Europe; to be replaced by PERSHING |
| **REGULUS I** (Navy) | Chance Vought, prime and guidance; Aerojet-General, propulsion | Surface-to-surface; turbojet & solid; 500-mile range; nuclear | Deployed aboard U.S. submarines; REGULUS II used as target drone |
| ★**SEMPER** (Marines) | No contracts announced | Believed to be an air-launched missile | R&D testing at Pt. Mugu |
| **SERGEANT** (Army) | Sperry, prime; Sperry, guidance; Thiokol, propulsion | Surface-to-surface; solid; more than 75-mile range; nuclear | In production |
| **SHILLELAGH** (Army) | Aeronutronic, prime | Surface-to-surface; lightweight; can be vehicle-mounted | Early R&D |
| **SIDEWINDER** (Navy-Air Force) | GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion | Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads | Deployed with Navy and Air Force; all-weather type under development |
| ★**SKY BOLT** (Air Force) | Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle | ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers | R&D; to be purchased by British; operational 1964-65; test-launching to be from Eglin AFB, Fla. Program spending being cut back |
| **SLAM** (Air Force) | No contract announced | Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead | Study-R&D |
| **SNARK** (Air Force) | Norair, prime; Northrop, guidance; ABL, propulsion | Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear | One squadron of about 20 missiles at Presque Isle, Maine |
| **SPARROW III** (Navy) | Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion | Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional | Operational with carrier aircraft; earlier SPARROW I obsolete; new contract extending range, altitude |
| **SUBROC** (Navy) | Goodyear, prime; Kearfott, guidance; Thiokol, propulsion | Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear | Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine |
| ★**SS-10** (Army) | Nord Aviation, prime; GE, U.S. licensee | Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional | Operational with U.S., French and other NATO and Western units; battle-tested in North Africa |
| ★**SS-11** (Army) | Nord Aviation, prime; G.E., U.S. licensee | Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional | Operational. Under evaluation by Army; decision on procurement due for some time |
| **TALOS** (Navy) | Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion | Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear | Operational aboard cruiser Galveston |
| **TARTAR** (Navy) | Convair, prime; Raytheon, guidance; Aerojet-General, propulsion | Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional | Operational on Missile Destroyer Adams in Oct. |
| **TERNE** (Navy) | Kongsberg Vapenfabrikk, prime; Arma, systems integration | Surface-to-underwater ASW missile; 264 lbs.; HE warhead | Navy buying from Norway to equip two destroyer escorts |
| **TERRIER** (Navy) | Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion | Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional | Operational with fleet |
| **TERRIER-ADVANCED** (Navy) | Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion | About 100% performance improvement over TERRIER | Operational Advanced TERRIERS to be deployed this year |
| ★**THOR** (Air Force) | Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle | Surface-to-surface IRBM; 1500-mile range; liquid; nuclear | Operational; 4 bases up in England. 65 military launchings: 44 successes; 11 partial failures; 42 scientific launchings successful, 2 partial; 6 failures |
| ★**TITAN** (Air Force) | Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle | Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range | 25 launchings test vehicles: 17 successes; 3 partial; 5 failures. 9 sites for 14 squadrons named; TITAN I operational mid-1961; first Vandenberg launchings from silo delayed by bugs up during fueling; TITAN II scheduled operational early 1963 |

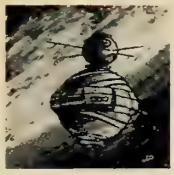
| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **TYPHON** (Navy) | Westinghouse, prime; Bendix propulsion | Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic | Early R&D; may be used on hydrofoil destroyers |
| **WAGTAIL** (Air Force) | Minneapolis-Honeywell, prime | Air-to-ground; low-level; solid; designed to climb over hills and trees | R&D |
| **WILLOW** (Army) | Chrysler, prime | Highly-classified missile | R&D |
| **ZUNI** (Navy) | Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion | Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional | Operational |



# Space Vehicles

| | | | |
|---|---|---|---|
| ★**AGENA** (Air Force) | Lockheed, prime; Bell, propulsion | 1700-pound satellite after burnout; AGENA B stop-start engine about double fuel capacity of AGENA A | Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR |
| ★**ATLAS-ABLE** (NASA) | STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion | Orbit 380-lb. vehicle around moon or send into deep space | Program ended with explosion of booster in flight Dec. 14. Launchings: 4; failures, 4 (3 failed in flight) |
| **BLUE SCOUT** (Air Force) | Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion | Solid multi-stage booster similar to SCOUT | First BLUE SCOUT launching partly successful in September |
| **CENTAUR** (NASA) | Convair, prime; Pratt & Whitney/JPL, propulsion; Minneapolis-Honeywell, guidance | Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe | First test flight in 1961; first engine delivered |
| ★**DELTA** (NASA) | Goddard, prime; Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion | Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity | Interim launch vehicle for TIROS-ECHO; to be used for other satellites and one deep space probe |
| **JUNO II** (NASA) | Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, propulsion | Early deep space booster; small payload | Two more shots planned |
| **MARINER** (NASA) | JPL, prime | 600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B | Seven shots planned beginning next year |
| **MERCURY** (NASA) | NASA, prime; McDonnell, capsule | First manned satellite; 1 ton capsule boosted by ATLAS | Program slipping about one year. First manned capsule launching by REDSTONE down Atlantic Range slipped to early 1961. First manned orbit shot scheduled for late 1961 |
| **NOVA** (NASA) | No prime announced; Rocketdyne, propulsion | Clustered 6-9 million lb. booster plus upper stages | R&D on 1.5 million lb. F-1 engines |
| **ORION** (Air Force) | General Atomic | Space station launched by series of atomic explosions | Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone |
| **PROJECT 3059** | Aerojet-General, Grand Central, propulsion | Solid motor in 1 million to 2 million lbs. thrust class | Research determining feasibility; NASA contracting complementary studies with United Technology |
| ★**ROVER** (NASA, AEC) | No prime announced | First nuclear rocket | Contracts to be let early 1961 |
| ★**SATURN** (NASA) | Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines | Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload | Second series of static firings in progress; first flight test spring of 1961; flight with live upper stages scheduled 1963 |
| ★**SCOUT** (NASA) | Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion | Solid four-stage satellite launcher; 200 lb. payload in orbit | First four-stage flight successful in Oct.; orbital shot failed in December. |
| **THOR-ABLESTAR** (Air Force-NASA) | STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion | Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine | THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **THOR-AGENA** (Air Force) | Lockheed, prime; Bell, propulsion | Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs. | Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61 |
| **TRIBE** (ARPA) | | Family of space launching vehicles | Planning |



# Satellites in Orbit

| SATELLITE | COUNTRY | STATUS |
|---|---|---|
| ★**EXPLORER I** (30.8 lbs.) | U.S. | Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 217 m., apogee: 1155 m., period: 107.2 min. (Discovered Van Allen Belt); not transmitting. |
| ★**VANGUARD I** (3.25 lbs.) | U.S. | Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 403 m., apogee: 2447 mi.; period: 133.8; still transmitting. |
| ★**LUNIK I "MECHTA"** (3245 lbs.) | RUSSIA | Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle; not transmitting. |
| ★**VANGUARD II** (20.7 lbs.) | U.S. | Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 348 m., apogee: 2049, period: 125.4 min., inclination to equator: 32.88°; not transmitting. |
| ★**PIONEER IV** (13.40 lbs.) | U.S. | Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory; not transmitting. |
| ★**EXPLORER VI "PADDLE-WHEEL"** (142 lbs.) | U.S. | Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit uncertain speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°; not transmitting. |
| ★**VANGUARD III** (about 100 lbs.) | U.S. | Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 320 m., apogee: 2313 m.; period: 129.8; not transmitting. |
| ★**EXPLORER VII** (91.5 lbs.) | U.S. | Launched 10/13/59, est. life 20 years, orbits earth, perigee: 344, apogee: 671; period: 101.1; transmitting |
| ★**DISCOVERER V CAPSULE** (less than 300 lbs.) | U.S. | Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months; period: 94.2; perigee: 123, apogee: 470. |
| ★**PIONEER V** (94.8 lbs.) | U.S. | Launched 3/11/60, est. life: forever; orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20; not transmitting. |
| ★**TIROS I** (270 lbs.) | U.S. | Launched 4/1/60, perigee: 429 m.; apogee: 465; period: 99.1 Picture-taking weather satellite; still transmitting. |
| ★**TRANSIT IB** (265 lbs.) | U.S. | Launched 4/13/60, est. life: 16 mos. minimum; perigee: 238; apogee: 426; period: 95.2. First R&D navigation satellite. Not transmitting. |
| ★**SPUTNIK IV** (10,008 lbs.) | RUSSIA | Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Last reported—Period 93.4; perigee: 175; apogee: 372. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket; not transmitting |
| ★**MIDAS II** (5000 lbs.) | U.S. | Launched 5/24/60; est. life: 40 months; perigee: 300; apogee: 315; period: 94.3; Telemetry for IR scanning failed two days after launch; still transmitting. |
| ★**TRANSIT II-A** (223 lbs.) | U.S. | Launched 6/22/60; est. life: 50 years; period: 101.6; perigee: 389; apogee: 650; still transmitting. |
| ★**NRLI "GREB"** (40 lbs.) | U.S. | Launched 6/22/60 with TRANSIT II-A; period: 101.6; perigee: 381; apogee: [illegible] radiation measuring satellite; still transmitting. |
| ★**ECHO I** (132 lbs.) | U.S. | Launched 8/12/60; est. life: one year; period: 117.5; perigee: 628; apogee: [illegible] first successful orbiting of a passive communications satellite. |
| ★**COURIER IB** (500 lbs.) | U.S. | Launched 4/10/60; period: 106.8; perigee: 586; apogee: 767; first successful launching of a delayed active repeater satellite; est. life one year; transmitting. |
| ★**EXPLORER VIII** (90 lbs.) | U.S. | Launched 3/11/60; period: 112.6; perigee: 259; apogee: 1420; launched [illegible] II; providing ionospheric measurements for communications work; est. life 2-3 months [illegible] mitting. |
| ★**DISCOVERER XVII** (2100 lbs.) | U.S. | Launched 12/11/60; period: 94.2; perigee: 114; apogee: 478. Capsule [illegible] covered by air snatch after 31st orbit for first time instead of 17th; contained human bio[illegible] specimens that were exposed to intense radiation. |
| ★**TIROS II** (280 lbs.) | U.S. | Launched 11/23/60; period: 98.1; perigee: 378; apogee: 459; tra[illegible] mitting. |
| ★**DISCOVERER XVIII** (2100 lbs.) | U.S. | Launched 7/12/60; period: 94; perigee: 150; apogee: 450. Capsule recovered and air snatched after 48 orbits; contained human bone marrow, cancer cells, [illegible] biological specimens. |



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CANNON PLUGS



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# Technical Countdown

## ELECTRONICS

### 'Electronic Catalogue' Will Speed DOD Supply

DOD has begun using new electronic supply information equipment designed to double the capacity of present methods. Up to 100,000 individual supply management actions can be handled each day. Heart of the system installed at Armed Forces Supply Support Center in Washington is an IBM 705-III electronic computer. The system's memory can magnetically store 1 billion characters of supply information covering 3.5 million items.

### Electronics Shows Gain in 1960

The electronics industry will set a new all-time high of $9.75 billion in factory sales for 1960—a 6% rise over 1959—says the Electronic Industries Association. And another rise of 6% to a $10.3 billion total in 1961 is predicted by EIA. Industrial products will be the biggest gainer, with military products close behind.

### Patent Granted on Semiconductor Radiators

A patent for 17 claims on semiconductor radiators has been granted to the Birtcher Corp. The patent (number 2,958,515) covers some 80-odd fin-type radiators.

### Aggies and Taws Speed Circuit Etch

The Army Signal Corps has cut the time required to etch a printed circuit from 2½ hours to seven minutes by using glass marbles. Costs are reduced by about 40%. The marbles, immersed in the etching bath are oscillated against the circuit board's surface to speed and improve the etching process.

### EIA Hits Tube/Transistor Imports

Electronic Industries Association has stepped up its campaign against the import of tubes and transistors with the distribution of a new booklet to 30,000 industry and government officials, technicians and purchasing agents. The little booklet, "Plus Values," takes the positive approach and presents some strong arguments for buying U.S.-made components—chiefly availability, services, and economic benefits.

### 'Helium Bomb' Tests Transistors

Transistor container leak rates as low as $10^{-6}$ cc/sec. reportedly can be monitored by a "helium bomb test" being used by Delco Radio. The method is more satisfactory and yields higher reliability than the previously used water vapor test.

## SUPPORT EQUIPMENT

### SS-FM Extends Telemetering Capacity

A new data multiplexing system to be used in *Saturn* combines single-sideband and FM and permits transmission of about 45 kc of data with 5% accuracy in the same r-f bandwidth used by FM-FM for 4 kc. In addition to a more-than-tenfold improvement in bandwidth utilization efficiency, up to 30 db improvement in S/N can be realized with the new technique.

### Signal Enhancement Ups Radar Efficiency

Simple signal enhancement operations can add radically new dimensions to existing radar according to a study completed by General Atronics Corp. for the Air Force. Results show that equipment can be designed for making direct measurement of speed, acceleration, and spin of targets from radar echoes. The theory also has application to sonar and pulsed communications systems.

## PROPULSION

### Screech and Chugging Under Study

Missile fuel supply failures due to "screech" and "chugging" are being studied by the University of California's Engineering Field School. Screech—a high-frequency phenomenon occurring when chemical reactions of two fuels resonate with combustion chamber volume—causes exhaust gases to punch holes in the chamber walls. Chugging—a lower-frequency effect due to uneven burning rate—results in an intense pressure-wave buildup which can blast or burn off the nozzle end.

### Pershing Motors Ready for Production

Thiokol is getting ready for the production run on *Pershing* propulsion units at Longhorn Arsenal, Marshall, Tex. A recent $1,139,675 contract will be used to procure motor cases from Curtiss-Wright and manufacture other inert motor component parts. Army spokesmen say Pratt & Whitney will continue R&D cases. Curtiss-Wright is a second source. It isn't certain whether Thiokol's continuous mix process will be ready for the start of production, probably in mid-summer.

## ADVANCED MATERIALS

### Rubber-Ammonia Compatibility Tests Developed

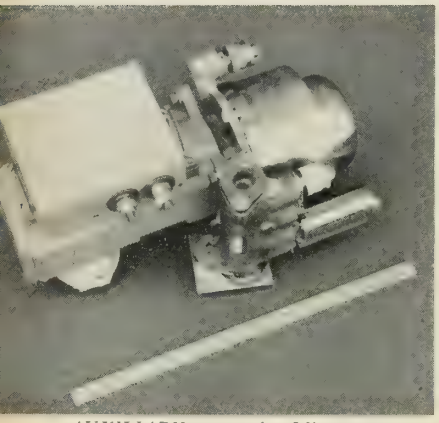
Procedures for determining the compatibility of rubber materials with anhydrous ammonia have been developed by laboratory engineers at North American Aviation's Missile Division. Prior to the development, little or no information on the problem was available to industry. The need for the tests developed when an O-ring was required in the anhydrous ammonia cooling system on the *Hound Dog* missile and its pylon.

### Soviets Have Large Scale Vacuum Degasser

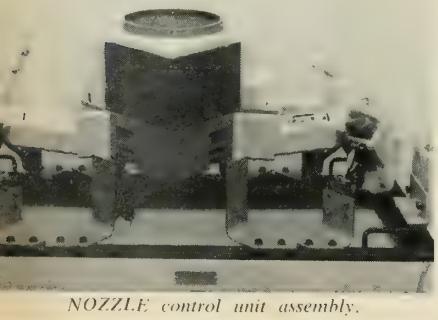
The largest vacuum degassing unit in the USSR, located at the Kramatorsk machine building plant, can accommodate up to 200 tons of molten steel. The plant is conducting experiments with vacuum degassing during the process of pouring from furnace ladle to pouring ladle. The possibility of using vacuum-degassed steel instead of acid open-hearth steel is also being studied.

# Minuteman Flight Control Aims at Lo

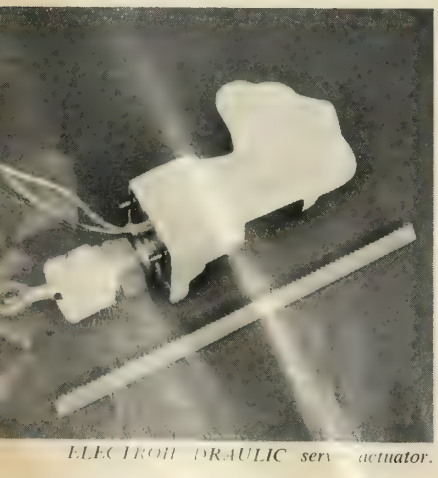
***Details of Autonetics system which will be key to superior performance of the solid-fueled second-generation intercontinental missile***



*AUXILIARY power for Minuteman controls.*



*NOZZLE control unit assembly.*



*ELECTROHYDRAULIC servo actuator.*

DOWNEY, CALIF.—The flight control system for *Minuteman* stresses simplicity, reliability and—because the ICBM is completely inaccessible in its silo—low maintenance.

"*Minuteman* is not a larger or more accurate missile," said Autonetics engineers L. J. Purpura and A. O. Greer, who spelled out details of the system. "It is only better insofar as its design philosophy and its reliability will carry it."

In the assembled *Minuteman,* they point out, the flight controls cannot be reached for repairs or even minor adjustments. Any malfunction or intolerable drift calls for a major missile disassembly.

• **Self-contained set-up**—Flight control is provided by a nozzle control unit (NCU) on each of the three *Minuteman* stages, giving pitch, yaw and roll control. Each NCU contains four electro-hydraulic position servos with associated equipment.

The missile hydraulic system is comprised of the four servo actuators and an auxiliary hydraulic supply, all married to a common platform. This platform serves as the hydraulic manifold, which features subassemblies of the plug-in type and uses internal ports as fluid ducts. It also serves as the component and subassembly mounting structure and the base structure for the fully integrated, closed hydraulic system.

The entire system is self-contained, and no external supply equipment is required. The system is cleaned, filled and bled in a controlled manufacturing area; field maintenance is not permitted.

• **Single-unit APS**—The auxiliary power supply (APS) converts DC current from either a ground power source or an airborne battery into hydraulic power. The APS is essentially a constant pressure source capable of simultaneously supplying a specified maximum servo-actuator velocity for all nozzles.

An integrated single unit, the APS consists of: motor assembly, noise filter and thermistor; pump assembly; check valve; filter; remote pressure indicator or switch; fill and vent quick-disconnects; bootstrap reservoir; and pressure transducer (for telemetry purposes only).

• **Praise for pump**—The hydraulic pump is coupled directly to a nominal 27v DC compound wound motor. Weight-to-output horsepower for this unit is about 2.3 lbs./hp. Due to large variations in the system power demand, a variable delivery pump is used to minimize energy consumption. Overall efficiency at minimum pump-flow demand is about 16.5%, and at peak power output about 63%.

Autonetics praised the Vickers, Inc. pump, which was developed for the system within five months of the contract award.

"Packaging concepts and weight considerations induced a rapid advancement in the state-of-the-art of hydraulic pumps," Autonetics said, describing the high-speed unit as a miniaturized, 905-series, fixed-angle, variable-displacement pump.

In this system, inlet pressurization obtained from the bootstrap reservoir is about 85 psi. The pump is designed to operate for rated continuous duty up to 18,000 rpm. Overall efficiency of the 25-degree-angle pump at full flow is about 82% at 12,600 rpm.

The remote hydraulic pressure switch used is a bourdon tube-switch combination. In operation, hydraulic pressure within the coiled bourdon tube causes it to unwind slightly, opening or closing the switch contacts within specified pressure ranges. (For example, the switch is open between 0-2800 psig, closed from 2800 to about 3350 psig, and open at higher pressures.)

The bootstrap reservoir is a fluid-storage sump; during APS operation it provides pump supercharge pressure through feedback of pump supply pressure to a differential area. The supply pressure to reservoir pressure is inversely proportional to the respective pressure-acting areas.

In the non-operating state, the mechanical bellows spring force overcomes the internal seal friction to compensate for fluid volumetric changes. No external dynamic seals are used. The stainless steel bellows can withstand 1000 psi steady-state pressure.

Drilled internal passages provide

## aintenance

porting for the hydraulic fluid (MIL-H-5606) in the APS manifold. Pump output is diverted through a modularized check valve to a common cavity which ports fluid to the hydraulic filter and vent disconnect. The remote pressure indicator and instrumentation transducer are located in the manifold, downstream from the filter. The filter (MIL-F-8815) has a rating of 15 microns absolute and a pressure drop of less than 10 psi at 3 gpm flow.

The APS transient response characteristics satisfy system requirements without the aid of a conventional accumulator. The time constant realized is 30 milliseconds or less, which corresponds to maximum acceleration on all four actuators.

Pressure oscillations superimposed on the pump output pressure bias are within 10% of system pressure during the course of the transient period and are completely damped within 0.8 seconds. Due to its compactness, Autonetics says, the miniture pump is easily packaged within the reservoir, thus minimizing the inlet flow restrictions and serving as an excellent heat sink.

The APS, with 10 cubic inches of oil in the reservoir, weighs about 18.2 lbs., including the pressure transducer for airborne telemetering.

• **Servo actuators**—Each of the four servo actuators on each stage is rigidly mounted to the basic platform structure. The piston shaft, connected to a floating link, is thereby connected to the clevis of the movable nozzle. The primary purpose of the floating link is to allow for misalignment between the platform assembly and the engine, and to provide for freedom of motion in the plane nozzle rotation.

Unique features of the servocylinders are:

(1) Modular servovalve eliminates breathing face seals and bolts.

(2) Torque motor separated from the hydraulic fluid minimizes effects of magnetic contamination.

(3) Internally, concentrically mounted feedback transducer provides maximum mechanical and thermal protection.

(4) AC position-feedback element gives essentially infinite resolution without wearing parts.

(5) Three-way servovalve reduces null leakage and the number of seals required.

(6) Wires, routed internally in actuator body and potted in place, provide maximum protection against high vibration and thermal environment.

To reduce the number of seals, the servo actuators employ a single-ended design, rather than the more conventional balanced design. System pressure, constantly applied to the small side of the 2:1 area, applies a retracting force on the ram which is opposed by the controlled ram force from the servovalve control pressure large area product.

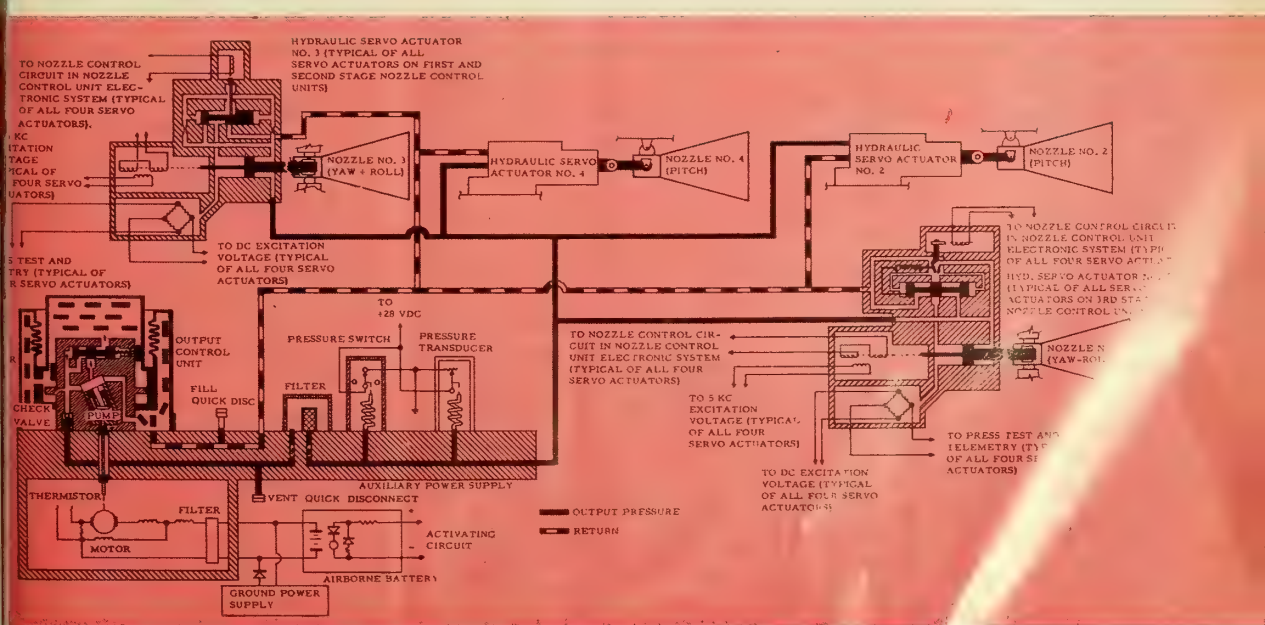
Thus, at a 3000 psi system potential, a net 1600-lb. retracting or extending force can be realized.

The three-way actuator design is inherently weaker in bearing-load capacity than the conventional, balanced double-rod, seal-type actuator, Autonetics said. However, the actuator is mounted tangentially to the movable nozzle clevis when in neutral, and with small angular deflections required, the worst side loading under stall load does not exceed 75 lbs. in any stage.

Seals in the actuator system are elastomeric, and include a single dynamic seal, five redundant pairs and two single static seals. The APS employs a face-type shaft seal, five redundant pairs and eight single static seals. Instrumentation seals are not included in these figures.

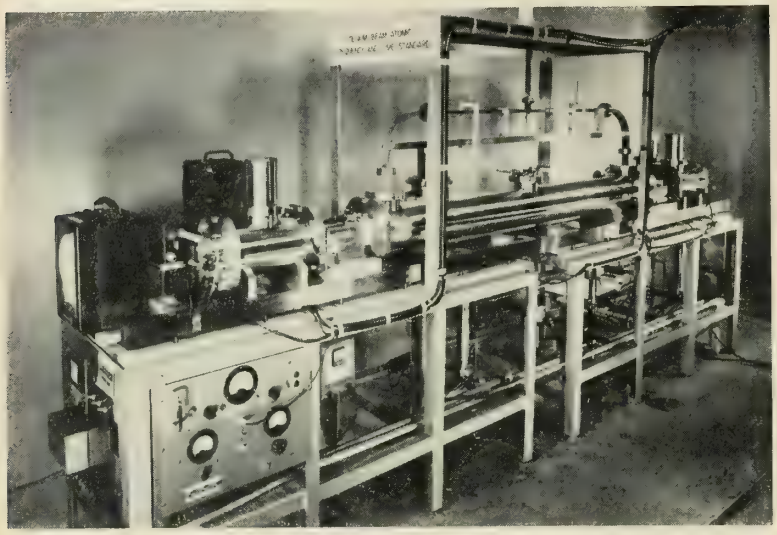
Airborne batteries for the *Minuteman* are energized during prelaunch stage, affording an opportunity to conduct a last-minute preflight check on the complete airborne system and also assuring battery activation. A weight premium is significant here, the company said, because the system peak-to-prelaunch valve leakage power ratio is 7:1.

The missile batteries are dry charged, primary silver-zinc type. The electrolyte is stored in a pressurized container and is discharged into the cells upon actuation. ⌗




*TYPICAL HYDRAULIC SYSTEM schema for nozzle control units associated with Minuteman guidance and flight controls.*

# Cesium Beam Is Leading To Improved Timing Accuracy



*NBS-II ATOMIC BEAM frequency standard is larger of the two being investigated at Boulder Laboratories. Separation between the oscillating fields inducing the atomic transition is 164 cm (64.5 in.). Spectral linewidth is 90-140 cps.*

NEED FOR EXTREME timing accuracies—for future radio communications, satellite tracking, control of long-range rockets, and astronomical observations—will be met by atomic frequency standards now being researched.

Scientists at Bureau of Standards Boulder Laboratories are currently experimenting with two dissimilar cesium-beam devices which are potentially three orders of magnitude more precise than present methods for time-interval determination. Such an improvement will answer the requirement for accuracies of one part in a billion, or better.

Scientific activities today rely on regular radio transmissions of standard frequencies from Bureau and Navy Stations: WWV, WWVB, WWVH, NBA. These broadcasts are based on astronomical observations related to the earth's rotation as made by the Naval Observatory. A far more accurate basis is needed for future activities, however.

Results of the NBS experiments, based on independent tests and measurements, show that cesium-beam devices of rather modest length (21.6535 in. between the oscillating fields for the shorter machine) can have precisions of $\pm$ 2 parts in $10^{12}$ for measurement periods of one to a few hours.

The frequency difference between the two machines ($10^{-11}$) has remained within $\pm$ 2 x $10^{-12}$ over the last nine months. Researchers feel that even better accuracy—up by at least an order of magnitude—should be attainable with some improvements in the apparatus.

• **Greater precision**—At present, radio transmissions controlled by the Bureau's master quartz-oscillators are being monitored with the cesium beam standards. Corrections for the 60 kc standard frequency broadcasts from WWVB at Boulder, Colorado, are being made each week and are available on request from Boulder Laboratories Corrections for the 20-kc/s transmission from WWVL will be available shortly.

Prior to the development of atomic frequency standards, the most uniform time-intervals available were those derived from astronomical observations of the rotation of the earth relative to the fixed stars corrected to the orbital motion of the earth about the sun. This orbital motion of the earth is the basis of Ephemeris Time. It has been measured with a probable error of 2 parts in $10^9$ in a period of three years. Higher precision is expected for longer measurement times.

Measurement of a frequency or a time-interval in terms of the cesium transition can be made with a precision of $\pm$ 0.2 cps and is not limited by the instrumental difficulties involved in astronomical observations. The precision of measurement for the atomic standards has proved to be two orders of magnitude better over a 2-minute period than astronomical measurements made over a period of 3 years.

The thallium atom as a frequency standard is also under investigation by NBS. Thallium has certain significant advantages over the cesium atom in this application, but may have some disadvantages in practical use. Boulder Laboratories are now putting a thallium beam into operation to determine which of the two atomic techniques is the more suitable. ⌗

## Raytheon Develops Device To Study Gas Composition

ENGINEERS AT RAYTHEON have come up with an omegatron mass spectrometer capable of determining the composition of a gas in the $10^{-5}$ to $10^{-9}$ M Hg range.

The apparatus consists of a small volume radio-frequency mass spectrometer operating on a cyclotron resonance principle; a very sensitive quartz microbalance which detects $10^{-7}$ gram weight changes; a system employing a modified Wagener technique to study getter activity and associated vacuum systems using oil, mercury, ion or cryogenic pumping.

Outgassing, sputtering, dissociation, adsorption and oxidation phenomena may be studied over a wide range of pressures and temperatures with the simultaneous identification of species involved.

In operation, the ions formed in the omegatron are separated according to their mass and a measurement of the ionic currents is an indication of their concentrations in the sample of gas present in the analyzing chamber.

Data readings of current and frequency on a recorder chart may be interpreted in terms of concentration of a particular gas as identified by its mass number. By running the available sweep of frequencies, the mass numbers of the low-molecular-weight gaseous components may be successively monitored and relative gas concentration estimated.

The omegatron is useful in examinations of the nature of gases evaporated from hot cathode surfaces; examinations of the penetration of gases through glass and ceramics: investigations of gases absorbed and released from metal surfaces; examinations of residual gases in diffusion pumps; investigations of aging effects in vacuum tubes and control of the composition of light hydrocarbon gas mixtures.

# SOCOM to Better Space Communication

***Electro-Optical's solar radiation system, tested in desert, offers vast improvements over conventional radio wave systems***

PASADENA, CALIF.—Electro-Optical Systems has completed first field tests of a 10-million-mile space communications system which uses solar radiation instead of radio waves.

The tests in the Mojave desert were to establish feasibility and check out prototype equipment.

EOS says the solar optical communications system (SOCOM) will be used in space for vehicles-to-vehicle, vehicle-to-station, and—under certain conditions—even station-to-earth communications.

It is being developed under contract for the Communication Laboratory of the Air Force's Wright Air Development Division.

The tests of SOCOM's prototype equipment were conducted over an eight-mile range using both the moon and sun as light sources. The transmission beam from the transmitter's emitting mirror to the receiver's parabolic collecting mirror was purposely attenuated to simulate distances from 1000 to 10 million miles. EOS engineers believe that in space, using the sun as the light source, SOCOM will be able to exceed 10 million miles with its signals, because of its highly directive antenna and high signal intensity.

• **Big weight, power advantages**—Several types of modulators for coding the light beam were used during the tests. Among these, the most suitable was a stressed plate shutter developed recently by EOS for the Army. This device has the advantages of light weight and low power requirement (approximately 3000 volts), and can accommodate large amounts of radiation without overheating.

Equipment used in the desert testing was far heavier than that which would be used in space. For instance, heavy glass mirrors were used to obtain high optical perfection at minimum cost. Actual weight of a space-launched SOCOM system is expected to be 30 to 40 lbs.

Electro-Optical explains that potential advantages of SOCOM over conventional radio frequency systems include lower weight and power requirements, more secure communications due to narrow beam width, superior reliability (from lack of high-power electronic components), longer range, invulnerability to electronic countermeasures, and a high signal-to-noise ratio in space.

In actual space use, SOCOM's operational cycle begins with collection of the sun's rays in a mirror antenna system. Radiation is then funneled through a modulator for coding and on into a second mirror system for emission through space to the receiving unit. The receiving unit also uses a mirror antenna system for collecting the signal. This signal is concentrated onto a detector at the focus of the antenna and then fed into a signal processing unit and finally read out. ⌘



*EXPERIMENTAL SOCOM transmitter on a 30-ft. tower during tests in the Mojave Desert. Both the sun and the moon were utilized as sources of light.*

# TFE Is Unperturbed by Radiation

***Insulation's high performance under space conditions has been proven both in lab tests and in transmissions from satellites***

THE RAVAGES OF space radiation have little effect on the dielectric properties of DuPont's "Teflon" TFE and FEP resins—a happy fact which ensures constant communications with long-lived satellites.

Laboratory evaluations of TFE fluorocarbon resins show a net change in weight of less than 0.003% after 72 hours exposure to a Cobalt-60 source in a $10^{-6}$ mm. Hg vacuum and at a temperature of 100°C.

"The resins have already proven their stability in space," says James P. Shoffner of DuPont's Polychemicals Dept., "fully 80% of the internal hookup wire in the *Explorer* series has been insulated with the TFE resins."

*Pioneer V*, which provided uninterrupted transmissions past the 5-million-mile mark, used an unprotected TFE-wrapped construction for the link between the paddle-arm solar cells and the vehicle.

*Vanguard I* is still broadcasting after 18 months, aided by fluoropolymer flush-fitting, feed-through insulators for the antenna system. Any degradation of the insulator would have resulted in antenna shorts—and communications failure.

**Teflon Under Radiation**

| | Radiation Dose,* x$10^6$ Rads | Elongation, % | Tensile Strength, Psi. | Dielectric Constant (±0.05) |
|---|---|---|---|---|
| Atmospheric | 0 | 165 | 3,000 | 2.1 |
| | 0.1 | 152 | 1,882 | 2.1 |
| | 0.5 | 37 | 1,539 | 2.1 |
| | 1.0 | 21 | 1,388 | 2.1 |
| | 5.0 | — | 1,322 | 2.1 |
| Vacuum $10^{-6}$ mm. Hg | 1.0 | 92 | 2,481 | 2.1 |
| | 5.0 | 73 | 1,972 | 2.1 |
| | 51.0 | 38 | 1,462 | 2.1 |
| | 150.0 | 16 | 800 | 2.1 |

*SAMPLE—0.010 TFE resin film at 25°C.*

• **Nature of radiation**—Shoffner said the various changes observed for irradiated plastics in either oxygen or vacuum environments can be understood if the existing types of radiation are considered.

There are two general classifications of radiation—electromagnetic and high-energy particles.

Electromagnetic energy includes radio transmissions with wavelengths several thousand meters in length, radar (meters to centimeters), infrared radiation, ultraviolet radiation, X-rays and gamma radiation.

Particle radiation encompasses tiny masses with varying weight and charge. With Teflon in mind, the most important are electrons, high-energy positive ions and neutrons.

In general, says Shoffner, when gamma or beta rays are absorbed by any material, there results both ionization and excitation of the molecules irradiated. Coincidentally, free radicals are formed.

The chemical changes occurring with formation of these radicals determine the extent of change in the polymer's physical and chemical properties.

Free radical formation can occur at any point in a complex molecule, and the extent of alteration is a function of electron density. Electrons and high-energy protons can produce considerable damage in all kinds of materials.

Protons with energy levels of 60-80 Mev exist in the lower Van Allen belts. These levels are appreciably above the inter-molecular binding energies of all chemical compositions.

High-energy neutral particles are present in the belts and in outer space. But neutron bombardment is of less importance in fluorocarbons than in hydrocarbons, says Shoffner. This is because of the fluoropolymer's lower capture cross section.

For example, the energy absorption of a Teflon TFE resin from fast neutrons is about 3% that of polyethylene. Minimized energy absorption is of prime importance in dielectric applications where original material properties must be maintained.

• **Design considerations**—Shoffner draws two conclusions from thermochemical calculations of bond energies for C-C and the C-F linkages of Teflon fluoropolymers. (58.6 and 107.0 kcal/mol, respectively).

The first is that C-C scission will predominate in competition with C-F scission as the energy-absorbing reaction. Fragment radicals of $C_3F_6$ and higher categories will result.

Secondly, free fluorine will not be liberated in preference to higher order C-F radicals under these circumstances, whether in air or vacuum. Experimental data has confirmed this.

Shoffner says that the use of Teflon fluorocarbons in space involves the following design considerations:

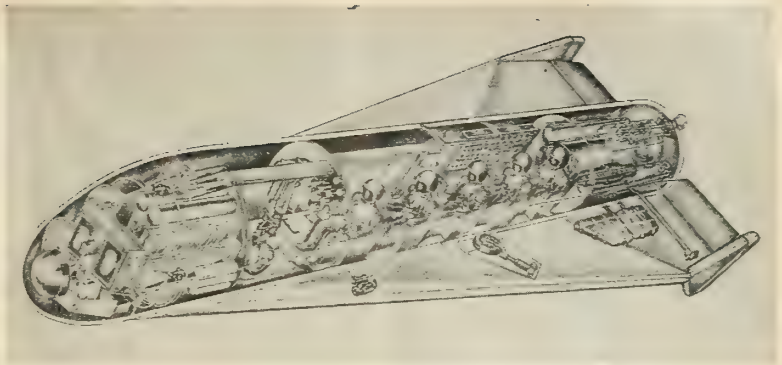
–With longer wavelength radiation, energy absorption will be exhibited as thermal heating. For applications involving skin temperatures of re-entry, these thermal effects are to be expected and adequacy will depend on temperature stability considerations.

–Space radiation intensities are such that ionization or activation is to be expected in spite of molecular composition. The behavior subsequent to, or during irradiation provides the true criteria for materials selection. Behavior refers to cross linking, favorable radical formation, etc.

Vacuum data places Teflon above the service levels for electronic hardware such as transistors, certain capacitors and specific glasses. ⌗

# Martin Co. Now Strictly Missile/Space Business

***Firm delivers last of 12,000 airplanes, expects space work to compensate for any defense drop***



*MARTIN VERSION OF SLOMAR shuttle vehicle will carry five men, or an equivalent amount of equipment, to a rendezvous in orbit with a space station. After delivering its load, the vehicle will return to earth by a glide re-entry pattern, slowing in the earth's atmosphere to landing speed.*

BALTIMORE, MD.—The Martin Co. moved entirely into the missile/space age Dec. 20 with the delivery of its last airplane, a P5M-2, to the Navy. Thus ended more than 50 years of aircraft manufacturing by Martin, which produced more than 12,000 planes.

Martin president William Bergen said that there was little fear that the defense industry would be out of business if peace should break out. Loss of defense business, he said, would be "more than offset with corresponding gains in the space business and in the business of devising and producing the complicated mechanisms of global surveillance that will be vital to keeping the peace once it has been achieved."

Already big in the aerospace business—which it entered in 1948 with the *Viking*—Martin expects to see sales this year pass the $600 million mark. Recent contracts awarded the company include a $250,000 study contract on *Apollo* and one for $140,000 on *Slomar*. Both these projects involve advanced manned space vehicles.

Glenn L. Martin, founder of the company, built his first airplane in 1909 —a bamboo-and-wire "kite with a motor" that flew from a California bean patch. Four years later he delivered to the Army his first military airplane, a model TT biplane that became the world's first bomber. In 1918, the company received an Army order for 20 of America's first twin-engine bombers, the MB-2, which became the Army's standard bomber for many years.

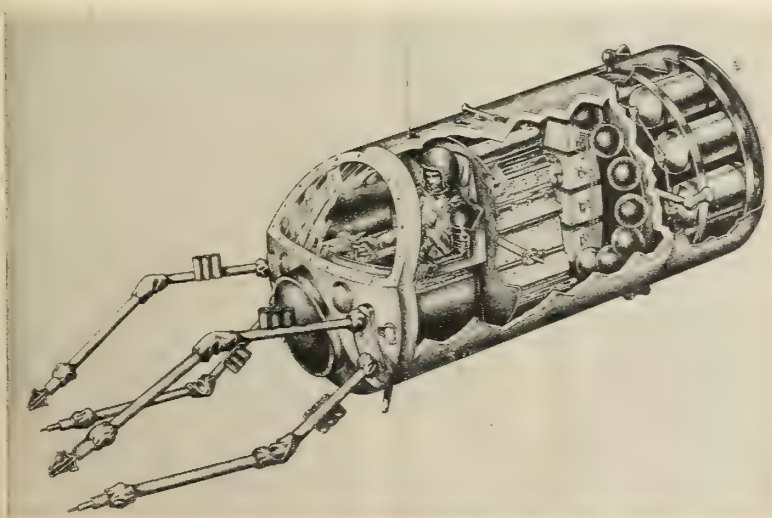
Later military models included the Navy's MC-1, first U.S. all-metal monoplane, the SC torpedo reconnaissance plane, the TM, and the Army B-10, which won the Collier Trophy.

During World War II, Martin built over 5000 B-26s for the Army and hundreds of PBM patrol bombers for the Navy. Other famous models included the Mars "flying warehouse," the China Clippers, the B-51, the B-57 (modified from the British Canberra), and the ill-fated P6M jet seaplane.

Martin entered the field of rocketry with the *Viking* high-altitude research rocket which set world altitude records and provided the background for Project *Vanguard*.

Its first Air Force missile was the *Matador*, first of a long string of operational missiles built or building by Martin. These include the AF and Navy *Bullpup*, AF *Mace*, Army *Lacrosse* and *Pershing*, and AF *Titan* ICBM. A modified *Titan* will provide the first-stage propulsion for *Dyna-Soar*.

Martin also has gone heavily into electronics and nuclear power units to supplement its aerospace activities. Typical of its activities in these areas is the Missile Master electronic air defense control system for the *Nike* missile, and SNAP III, a small nuclear power unit for space application. ⌗



*ONE-MAN SPACE TUG being studied by Martin under the Slomar contract would be used for assembling a large space station in orbit. The tug would be equipped with power tools and remotely controlled manipulators operated by the technician inside the vehicle. The 8000-lb. tug would contain a computer, an autopilot to prevent tumbling, a reaction motor and supplies for 48 hours.*

# Europeans Map Joint Space Research

***Preparatory panel to determine what might be accomplished by 10-nation group; U.S., British Space Vehicles may be sought***

**by Anthony Vandyk**

GENEVA—A European space research organization is likely to be set up in about a year's time.

At an intergovernmental conference on space research held here last month, 10 European nations signed an agreement setting up a commission to prepare for establishment of a permanent organization for collaboration in space research.

The agreement comes into force when six member states, whose contributions amount to at least 70% of the $192,838 budget, have either signed it without a reservation as to ratification or else ratified it after having signed it subject to such a reservation. The following nations signed without reservation: Belgium, Netherlands, Norway, Sweden and the United Kingdom. The following signed with reservations: Denmark, France, Italy, Spain and Switzerland. West German will sign later.

• **French headquarters**—The Preparatory Commission will work out of Paris under the presidency of Professor Pierre V. Auger, noted French space research expert. He will be assisted by two vice presidents and a small secretarial staff. The first meeting of the Preparatory Commission will be convened in Paris within 30 days after the agreement goes into force, probably early this year.

The most important task of the Commission will be to determine the scientific program for the permanent organization. The limiting factor here will be cost. Moreover, the programs will have to be related to payloads actually feasible, the orbits and the firing program.

Following are types of satellites on which research might be carried out by the organization: a) 500-kilogram satellites, highly stabilized on universal axes; b) 250-kilogram satellites, stabilized on terrestrial axes; c) sun-orientated satellites, weighing less than 250 kilograms; and d) non-stabilized satellites weighing between 50 and 100 kilograms.

The Preparatory Commission will have to study the possibilities in obtaining vehicles and using launching sites. It is hoped that the British will allow *Blue Streak* to be used as a first-stage rocket. The permanent commission will also consider under what conditions U.S. missiles such as *Thor* and *Atlas* might be secured.

• **Launch sites**—It will also investigate whether the French missile range at Colomb-Béchar and the Australian range at Woomera could be used as launching sites for the organization's work. A check will also be run with the U.S. government to see whether the organization might be permitted to make use of the facilities at Cape Canaveral.

It is expected that a fairly large part of the permanent organization's budget will be devoted to research in such fields as propulsion, power sources, information storage and transmission, solid state physics, surface coatings of controlled emissivity, high vacuum technology, sensitive detecting devices, and the behaviour of materials under high vacua.

Another suggested role for the permanent organization is the investigation of the possibilities of setting up and using telemetry networks and tracking stations both for satellites of the Earth in reasonably near orbits and for deeper space probes. The possibilities are: a) use of the existing facilities with the study of the conditions of their use; b) development of facilities of this kind; and c) the setting up of new stations.

The proposed program for vertical rocket soundings by the European organization will include the following studies: 1) synoptic study of the atmosphere from 30-90 kilometers; 2) synoptic study of the atmosphere in the region of 90-200 kilometers; and 3) study of solar activity.

• **Light orbiters**—In the satellite field, the first phase of the permanent organization's program might include the putting in orbit of small satellites (of the order of 100 kilograms). Such satellites would be sufficient to carry out research requiring no heavy scientific equipment, they would permit to build up European scientific teams with enough experience to make a full contribution to space research.

This first phase might last about three years and would entail the following steps: 1) detailed study of ionospheric structure, constitution and temporal behavior, together with continuous monitoring of solar activity in the ultraviolet and X-ray regions; 2) radioastronomy in the regions of the radio spectrum inaccessible from the ground; 3) meteorological studies; 4) geodetic and time measurement problems; 5) study of cosmic rays and other particles (including meteors) in the upper atmosphere.

A second phase, coming into play after five years, would see the launching into terrestrial orbit of 500-1000 kilogram satellites, and the sending into the lunar field of lighter payloads. More elaborate satellites, endowed with highly stabilized devices, would then be developed.

During this second phase, the following experiments might be undertaken: 1) detailed study of stellar ultraviolet and X-ray spectra; 2) detailed study of solar disk in ultraviolet and X-ray regions of the spectrum; 3) study of interplanetary and interstellar absorption; 4) study of cosmic rays and other particles in interplanetary space; and 5) advanced meteorological studies.

The third phase, which should be developed in parallel with the first two, would include studies and projects likely to evolve during the following years into development of devices capable of landing scientific equipment on the moon, exploring other planets and studying the sun's neighborhood. These studies would deal with: 1) lunar and planetary physics; 2) astronomy; 3) space biology.

To carry out such a program, the permanent organization would have to: 1) proceed immediately to ensure the availability of launching potential for payloads weighing about 100 kilograms; 2) proceed immediately to ensure the availability of means for providing highly stabilized satellites and deep space probes; and 3) undertake, from

*(Continued on page 40)*

# Astropower Head Outlines R&D Plans

SANTA MONICA, CALIF.—Y. C. Lee, president of Astropower, Inc., the new propulsion subsidiary of Douglas Aircraft Co., says the firm will carry out substantial research and development programs in nuclear, chemical and electrical propulsion.

Lee outlined long-range plans and programs of the new firm in a recent interview.

He said Astropower's interest in chemical propulsion will lead into research of extremely high-energy chemical propellants, storable propellants and the combination of cryogenic propellants with additives to form a tribrid system.

Lee reported that Astropower plans investigation of thermal arc plasma engines, ion engines and colloid or heavy-charged particle engines. Major activity is also expected in solid-state devices and energy conversion equipment. This technique, Lee suggested, might be used for micro-thrust rocket engines and to power the various systems in space vehicles.

• **Technical autonomy**—Although Astropower was organized as a Douglas subsidiary, its relationship is purely financial, Lee reported, and all technical programs will be completely separate. Astropower services will be offered to government agencies and major systems contractors, including Douglas itself. The firm also plans to develop commercial products.

Permanent home for Astropower probably will be in the vicinity of Newport Beach, Calif., according to Lee. Sites there are now being surveyed.

"Initially we are planning the construction of a building that will house research laboratories, engineering quarters and administrative offices," he said.

Equipment in the laboratories is to include a hypersonic plasma tunnel to investigate the behavior of ionized gases and an extremely high-vacuum facility to simulate space environment.

• **Organization**—The professional staff of Astropower is to number between 100 and 150 in the first year, plus supporting administrative personnel. The technical staff will be headed by chief engineers in the fields of chemical propulsion, nuclear propulsion, electrical propulsion, power equipment and power source systems.

In addition, Astropower will have chief scientists directing research activities in plasma physics, solid-state physics, magnetohydrodynamics and materials. ⌗

## AIA's Cook Sees No Change in Sales

NO SURPRISES are in sight during 1961 for the aerospace industry.

Indeed, Aerospace Industries Association President Orval Cook forecasts that the industry's sales volume will remain exactly at the 1960 level of $11 billion—with missiles continuing to command a larger share of the DOD dollar.

In his annual year-end review of the state of business, Cook predicted that R&D contracts "will be subject to increasing selectivity and . . . far more competition."

Recapping 1960, Cook said sales were broken down into $4.1 billion for missiles and $6.9 billion for aircraft for the 12 major airframe companies. The number of military aircraft fell to 1200 from the 1959 figure of 1700 units.

Cook noted that employment in the aerospace industry had continued to decline and was the lowest since 1955. The trend has been towards more highly skilled and higher-paid personnel, he said, with an average weekly wage increase of about 4% over 1959.

Along with this realignment of the labor force has come a 50% reduction in plant area requirements over the past three years but a high obsolesence rate and need for more sophisticated facilities, especially for R&D. The industry has had to invest almost $2 billion in new facilities in the past five years, Cook said, and this has contributed to the steady decrease in earnings. As a percentage of sales, earnings have dropped from 3.8 in 1955 to 1.5 in 1959; as a percentage of net worth, from 21.4 to 8 since 1955.

The aerospace backlog was estimated to be up a bit over last year. As of Sept. 30, 1960, orders on the books amounted to $12.5 billion, up $400 million from the 1959 figure. This increase was due to other military products which more than offset the decline in military aircraft procurement.

## Moon Dust May be Thin Enough for Soft Landings

DUST ON THE MOON may be shallow enough in some places to permit safe landing by spacecraft.

Recent infrared "heat mapping" conducted by a Boeing Aero-Space Division team has brought evidence of considerable variation of the lunar dust layer. This is in direct contrast to the widely-held opinion that the moon was covered with a uniformly deep blanket of pulverized moon dust.

Boeing scientists based their conclusion on the fact that some moon craters retain solar heat much longer than do the plains or the waterless seas. The studies were conducted during the March 13 eclipse with the 73-in. reflecting telescope at Dominion Astrophysical Observatory, Victoria, British Columbia.

A second and confirming observation was made with the 60-in. telescope at Mount Wilson Observatory, Calif., Sept. 3, 4, and 5. A total eclipse occurred Sept. 5. More than 1 million square miles of the moon's surface were studied.

On each occasion, the moon was tracked by telescope while a radiometer measured total IR radiation received from a "sawtooth" scan of several parts of the moon's surface. Scanning was continued as the moon became enveloped in the earth's shadow and was cut off from solar light and heat for about three hours.

It was found that most of the moon cooled quickly to below 100° F, but the craters Tycho, Copernicus, Kepler and Aristarchus registered a temperature of about 0° F.

The Shorthill-Saari Thermal Contour maps, on which moon surface temperature differences discovered in the study are charted, follow with remarkable correlation the physical features of the moon.

The Boeing group pointed out that there are several other possible interpretations of this temperature change, including internal heating of radioactivity of materials in crater areas.

## . . . Mariner Fly-bys

*(Continued from page 15)*

perature rises, and its resistance decreases. Since the compensating flake is shielded, its resistance is unaffected by the radiation.

As a result, the output voltage at the junction of the two flakes changes by an amount that is precisely proportional, over a tremendous dynamic range, to the power of the incident radiation.

Germanium-immersed thermistor detectors provide increased optical gain directly at the detector. The overall detectivity of the system is reportedly increased by a factor of about 3.5 simply by replacing the conventional unimmersed thermistor bolometer detector with the immersed detector having the same field of view.

The detector capsules are hermetically sealed and usually evacuated to eliminate "swish" noise from convection air currents. The hermetic sealing requires that IR transmitting windows be fitted, and that leads be brought through glass-to-metal seals in the base.

In common with most radiation detectors, the detectivity of thermistor bolometers increases with decreasing detector area. This is used to practical advantage by immersing the reduced active thermistor element at the rear of a germanium lens which focuses the incoming radiation upon the smaller detector.

For this job, germanium is used in preference to other materials because of its high index of refraction, its desirable spectral bandpass characteristics, and its adaptability to the manufacturing process.

Some invitations to bid have already been issued for design studies of the required instrumentation for the first *Mariner* flight and for the lunar soft-landing mission (Project *Surveyor*). Separate study contracts for payloads for later spacecraft have not been started. However, JPL has told some of its present contractors to extend their study efforts to include design conditions brought in by advanced spacecraft. ⌗



### Segmented Success

*THREE-SEGMENT, 15,000-lb.-thrust solid-rocket motor was fired successfully for 50 seconds recently by United Technology Corp. under a NASA-sponsored study. The space agency is considering spending more funds for further study.*

## . . . Brookings Report

*(Continued from page 18)*

policy-making body that President Eisenhower sought to abolish.

• **Working paper?**—It is understood that Johnson intends to staff the NASC with several dozen specialists in areas of government policy related to space. Thus it is possible the Brookings report might provide the council with a working paper on at least some phases of its responsibilities. Under the Eisenhower administration, the council has been merely a high-level committee that met infrequently.

By law, the council consists of the President, the secretary of state, the secretary of defense, the NASA administrator, the chairman of the Atomic Energy Commission, one other government member and three non-government members. The council now has a staff consisting of David Z. Beckler, acting secretary, and his secretary.

Michael agreed that many of the investigations proposed in the Brookings report might well be conducted by other government agencies than NASA. He emphasized that NASA had given his group no guidelines, other than to ask for recommendations on how it might comply with the provision of the Space Act calling for long-range planning.

Some proposed areas of investigation:

–Implications of satellite-based communications systems. Frequency allocation and sharing, international agreements on compatability of equipment components, priorities and cost-sharing arrangements for satellite, transmitter and receiver use, access to audiences, program content control, government-industry relationships, differing relationships in other countries, and the possibility that competing satellites might be launched by the USSR or another nation. Such studies might also be conducted by the Federal Communications Commission.

–Implications of a space-derived weather predicting system. Setting rules for exchange of information, even though weather information will be important militarily, cost-sharing arrangements and location of ground facilities, organizational arrangements, obtaining trained personnel, and implications for weather control, agriculture, tourism, water resources, transportation and disaster mitigation. Such studies might also be conducted by the U.S. Weather Bureau.

The report also proposes investigations of implications for international affairs, which might be conducted by the State Department, implications for industry, which might be conducted by the Commerce Department, and implications for scientific manpower and overall government operations, which might be conducted at White House level. ⌗

## . . . European Research

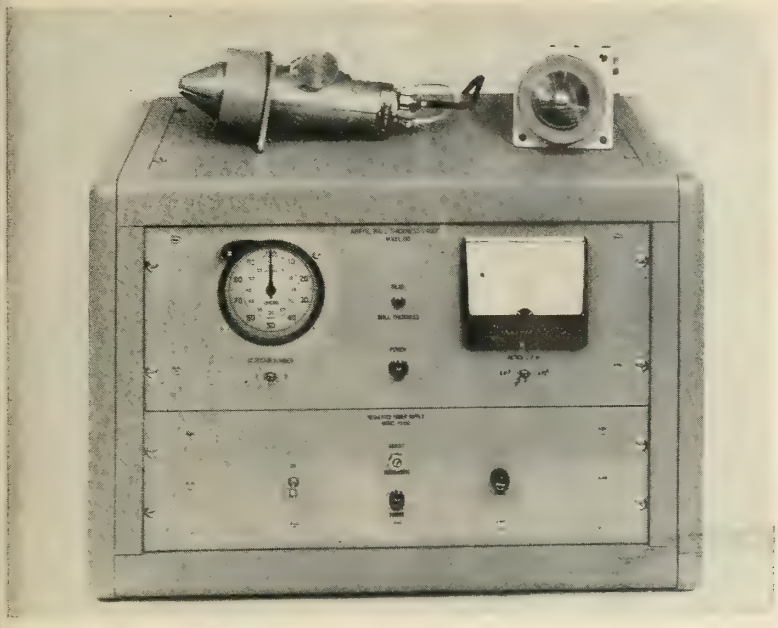
*(Continued from page 38)*

the start, research in the advanced systems necessary to make possible the third part of the program.

• **Organization's advantages**—What are the advantages for Europe in having a permanent organization for space research? The direct technological and economic advantages will be: Coordination of buying, research and development, and of standardization will bring economy. Pooling of knowledge, skill and resources will make possible the economic development of facilities which might not be otherwise possible, e.g. advanced propulsion systems, highly stabilized platforms, satellite recovery, adequate tracking and date recovery. Centralization of the engineering skills required for payload engineering will be of great value to all, but especially scientists from the smaller nations. Centralization and pooling of data-processing equipment for use by all will make for efficient economic data handling.

There will be indirect benefits. The various advantages accruing from space research will be directly available to Europe. There will be much stimulation of technological research and of scientific research in universities.

Various fields of research may be mentioned, e.g.: a) technology of materials (such as special steels, new alloys, plastics) including studies of resistance to erosion, to high temperatures, to high vacua, and to radiation; b) miniaturization of electrical and mechanical devices; tracking and remote-control steering. ⌗



## Thin Wall Thickness Gauge

A nuclear wall thickness Gauge is being marketed by Franklin Systems, Inc., Primary advantages over other previous methods are the extreme range of the instrument, which can measure from 0.02 to 0.150 inches; plus the fact that users do not require an AEC license.

With the Franklin gauge (Model 130), a measurement is made by placing an extremely thin (0.03 inch maximum diameter) radiation probe internally so that soft gamma radiation travels through the wall to be measured on the detector heads. A 50 Microcurie Radium D soft gamma radiation source and scintillation counting techniques are used to perform the measurements.

The range and accuracy of the gauge is within ± 5% of the wall thickness over a range of 0.015 to 0.120 in. However, for those that require finer tolerances, the gauge can be made with an accuracy of plus or minus 0.001 in. over an extended range of from 0.005 to 0.200 in.

Circle No. 225 on Subscriber Service Card.

## High Vacuum Coupling

A line of Ultra-High Vacuum Couplings is being marketed by Cajon Machine Co. When using these couplings, no leaks are detectable or measurable on a Helium Mass Spectrometer with a sensitivity of 1.7 x $10^{-10}$ atmos. cc/sec/division. In addition to the simplicity of repeated assemblies, the all metalic design will permit operation at elevated temperatures.

Circle No. 226 on Subscriber Service Card.

## Hydraulic Relief Valve

An inverted design miniature relief valve from Benbow Manufacturing Corp. eliminates over-travel, chatter and slamming while maintaining desired system pressure.

Lightweight and miniaturized, these valves offer a wide variety of port sizes, male and female, straight flare or bulkhead. The valves exceed requirements of MIL-V-5523 with zero leakage internally.

Circle No. 227 on Subscriber Service Card.



## Universal Tracer System

A 360°, two-axis, electro-hydraulic tracer system, featuring absence of contour limitation except as might be created by the cutting tool is available from Monarch Machine Tool Co.

The tracer head utilizes a variable reactance device which sends signals to an electronic control console for interpretation and amplification. Modulated signals from the console provide electro-hydraulic servo valve control for regulating oil flow to the hydraulic motors. The electronic equipment is in the form of fully transistorized plug-in modules.

Circle No. 228 on Subscriber Service Card.

## High-Temperature Bearing

A precision ball bearing capable of operating at temperatures up to 575°F., without conventional lubrication has been developed by The Barden Corp.

Known as BarTemp, the bearing was designed for the needs of newer types of synchros, motors, blowers and fans that operate at far higher temperatures than their predecessors. Heretofore, bearings used in similar applications have been limited to operating temperatures of around 300°F.

Circle No. 229 on Subscriber Service Card.

## Two-Color Optical Pyrometer

A two-color optical Pyrometer, PYRO-EYE, for completely automatic, continuous, measurement and control



of temperature in the ranges from 1400°F to 4500°F and from 750°C to 2500°C is available from Instrument Development Laboratories, Inc.

PYRO-EYE is available in two models: one for fixed mounting in production areas; the other, portable for laboratory use. Each of these models may be had in single, double or triple ranges. They measure temperatures at any distance from 20 inches to 60 feet from the target and are applicable to many processes.

Circle No. 230 on Subscriber Service Card.



## Radioactivity Scaler

A laboratory instrument that transforms any scaler with a high voltage supply into a complete proportional counting system is available from Nuclear Measurements Corp.

Known as a proportional counter converter, Model PCC-11A, the unit connects to the scaler and plugs into any 110-volt circuit for precise detection and measurement of alpha, beta and gamma radiation in prepared samples. It discriminates between alpha and beta by high voltage setting only.

Circle No. 231 on Subscriber Service Card.

## High Pressure Bleed Valve

A compact, light weight, leakproof and almost universally applicable high pressure bleed valve, P-416 type, is available from James, Pond & Clark, Inc. Purpose of this valve is to bleed off or blowdown high pressure gas or hydraulic systems.

Weighing only 0.06 lbs., operable at temperatures ranging from –65° to 300°F, and with an operating pressure range of from 0 to 3000 psi (proof pressure, 4500 psi; burst pressure over 7500 psi), the P-416 type is ideally suited for aircraft or missile installation.

Circle No. 232 on Subscriber Service Card.

## Shock Testing Machine

Hardigg Industries are marketing shock testing machine for the drop testing of electronic devices and other fragile equipment up to 150 lbs. Machine will find fragility of product itself and can also be used to test ability of cushioning material to meet military and commercial specifications.

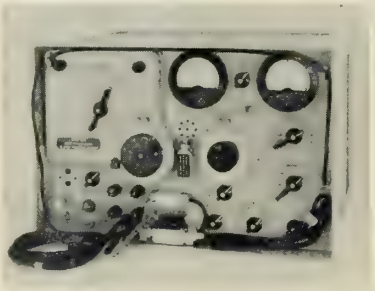
Shock Tester can be used in conjunction with the Hardigg Air Cushion, which produces a known reproducible shock pulse, with negligible rebound. The unique construction of the vertical guidance system and extremely rigid platens make for precise and convenient operation.

Circle No. 233 on Subscriber Service Card.

## Flexible Signal Generator

A wide range of frequencies is available in a Signal Generator, No. 12/U, manufactured by Systems, Inc.

It is a precision test instrument designed to provide f-m and unmodulated r-f signals for various measurements and alignment. One of the two output cables supplies output voltage at nine different crystal-controlled frequencies which coincide with the intermediate frequencies used by various receivers to be tested. The second output cable supplies r-f output signals in a frequency range of 20 to 100 mega-



cycles in five bands. The r-f output is variable from 0.05 to 10,000 microvolts; the i-f output, from 0.5 microvolt to 1 volt.

Circle No. 234 on Subscriber Service Card.

## Solid-State Transmitter

A compact, solid-state transmitter is available from Cubic Corp. The transmitter's circuitry incorporates a reactive multiplier which permits operating the basic oscillator at 56.25 mc. Through successive multiplier stages, this frequency is stepped up to the output frequency of 224 mc.

The transmitter is capable of 1 watt power output without exceeding the design limitations of the transistors, while short periods of 2.5- and 3-watt operation are also possible.

Circle No. 235 on Subscriber Service Card.

## Function Generator

A function generator that provides any waveform at repetition rates down to one cycle every 200 seconds has been introduced by Advance Components Ltd., a British firm, through its U.S. distributor, General Measurements Co.

Called the SG88 V.L.F. Function



Generator, it is designed to fill the gap in the range of laboratory instruments currently available. It is intended for the solution of many simulation and computer design problems, for servo-system analysis, vibration testing and numerous similar applications. The unit eliminates the need for specially shaped and wound potentiometers and complex electronic wave-shaping circuits.

Circle No. 236 on Subscriber Service Card.

## Servo-Valve Monitor

Model 1000-7 Servo-valve Monitoring System is available from Standard Controls, Inc.

It consists of three pressure transducers mounted on a thin manifold block which fits between the servo-valve being monitored and the hydraulic system manifold. A 3000 psi differential transducer gives a constant readout of the pressure difference between the two control ports of the servo-valve. A 3000 and a 300 psig transducer give constant indications of the pressure at the supply and return ports.

Circle No. 237 on Subscriber Service Card.

## Conforming Polymer Seal

A spring-loaded self-conforming polymer seal for applications in reciprocating and low-speed rotary shafts under high pressure liquid and gas conditions is available from Del Manufacturing.

The seal combines polymer and spring steel in a principle insuring efficient operation over a temperature range of –320° to 500°F and under pressures up to 10,000 PSI.

Circle No. 238 on Subscriber Service Card.

## Hydraulic Line T-Fitting

A Tylock 4-Seal T-Fitting which eliminates the need for adapters, con-

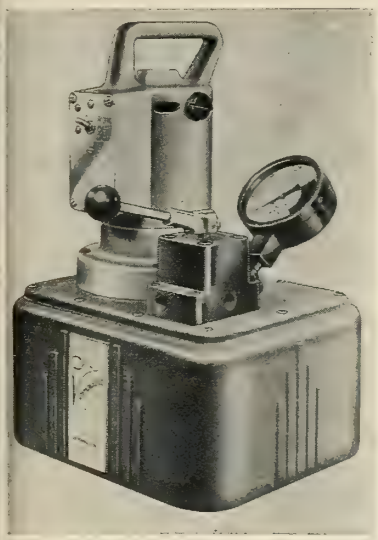


nectors and special fittings when applying pressure gauges or other instruments to hydraulic, pneumatic and process lines is available from C. B. Crawford Co. The fitting embodies four positive seals against pressure, temperature, vibration, surge, plus vibration dampener.

Circle No. 239 on Subscriber Service Card.

## Two-Stage Hydraulic Pump

A two-stage hydraulic pump which delivers from 600 cu. in./min. at 100 p.s.i. to 50 cu. in./min. at 10,000 p.s.i., and weighs only 45 lbs., is available from the Precision Hydraulics Division of the Owatonna Tool Co.



The OTC "Vanguard" complete pumping unit is a quiet-operating, two-stage unit, driven by a universal motor, and consisting of a gear pump for the low-pressure stage and a five-cylinder axial-piston pump (which is supercharged by the gear pump) for the high-pressure stage.

Circle No. 240 on Subscriber Service Card.

## Enclosed Induction Motor

Kearfott Division of General Precision, Inc. has available the BF 15-14 unit addition to its line of miniature and subminiature special motors. This motor is designed to function primarily as the driving unit for diverse fuel, air, and hydraulic pumps. The unit operates without diminished performance in severe environments.

Circle No. 241 on Subscriber Service Card.

## Vertical Motor Generator

A vertical motor generator that eliminates shaft deflection and, therefore, vibration is available from Leach Corp.

The vertical unit is an addition to the Leach brushless synchronous line and will handle ratings from 125 KW to 175 KW.

A unique feature of the equipment is that the magnetic forces on the rotor produce a slight lifting action in the vertical direction, thus taking most of the load off the thrust bearings.

Circle No. 242 on Subscriber Service Card.

## Magnetic Pilot Valve

A pilot valve for the actuation of large control valves is available from Marotta Valve Corp. The PLV-1 series is rated as a small flow, N.O. and N.C., 2 and 3-way, 3000 p.s.i.g., (10,000 p.s.i.g. burst) pneumatic service valve. Capacity is rated by an equivalent sharp edge orifice diameter of 0.030 in. Operated electrically on 18-30 VDC through either standard MS receptacle or pigtails.

Circle No. 243 on Subscriber Service Card.

## Tiny Strain Transducer

Statham Instruments, Inc., is marketing a micro-miniature, flush-diaphragm, absolute-pressure transducer featuring high frequency response. Model P318 weighs 0.5 grams, with dimensions only 0.59 in. diameter by 0.050 in. thick.

Ranges for the P318 are 0-10 psi to 0-100 psi, available in absolute, gage



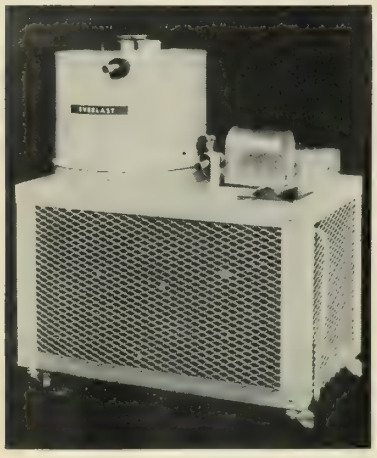

Circle No. 6 on Subscriber Service Card.

or differential. Excitation is 15 volts. Output is 5 millivolts, full scale open circuit. The combined error due to nonlinearity and hysteresis is less than ±1.0% of full scale. Ambient temperature limits are −65° to +150°F.

Circle No. 244 on Subscriber Service Card.

## Portable Lab Freezer

A low-temperature portable freezer that may be used as a dry air storage unit to −60°F, or as a circulating brine chilling device to −30°F, has been developed by Everlast Refrigeration Co.




The Everlast CIRCU-FREEZE, consists of a refrigerating unit with Freon 22, sealed compressor with a 1/3 hp motor, heavy stainless-steel drum, circulating pump, inlet and outlet fixtures, all mounted on a rigid frame with four rubber casters.

Circle No. 245 on Subscriber Service Card.

## Rotary Component Balance

A dynamic balancer is available from Micro Balancing, Inc. Employing unconventional design techniques to achieve unprecedented accuracy the balance eliminates the erroneous effect of component vibration and substantially reduced the mass typical of conventional balancing machine frames.

The sensitivity of Model SU-7 is 0.00001 inch of measurable unbalance displacement.

Circle No. 246 on Subscriber Service Card.

## Self Tuning Sonic Cleaner

Constant maximum efficiency can be had in the biggest cleaning operations with Powertron Ultrasonic Corp.'s Autosonic Series 1000 ultrasonic cleaners. The units, require no operator attention or tuning, and maintain optimum cleaning performance by means of an feedback transducer which compensates for all varying load conditions.

Circle No. 247 on Subscriber Service Card.

# new literature

TRANSISTOR TESTER—Design specifications for the direct reading, variable duty cycle power transistor test set, Model NC-1, are available from Baird-Atomic, Inc. The technical data sheet gives full information on the new instrument, which can test both medium and high power transistors.

Circle No. 200 on Subscriber Service Card.

DOD DATA MICROREPRODUCTION—A six page folder discussing the new standards and specifications of the Defense Department's engineering data microreproduction system is available from Minnesota Mining and Manufacturing Co. Since the system is based upon the use of aperture cards as the standard medium for exchanging engineering data, an explanation of these cards is given along with illustrations.

Circle No. 201 on Subscriber Service Card.

SINGLE SHAFT GAS TURBINE—Bulletin 198, issued by Clark Bros. Co., describes the company's 9000 hp Single Shaft Gas Turbine. Primary design considerations of simplicity, low first cost, easy access to all areas and high reliability are first discussed, followed by a detailed description of major components.

Circle No. 202 on Subscriber Service Card.

ANGULAR ACCELEROMETERS—Features, applications and specifications of angular servo accelerometers manufactured by Donner Scientific Co. are included in a six-page brochure available from the firm. The units described are intended for control and measurement of missile and aircraft flight dynamics; structural analysis of induced angular acceleration; monitor and control of servo systems, and closing the loop in inertial guidance systems.

Circle No. 203 on Subscriber Service Card.

BALL BEARING BULLETIN—A newly revised publication, American Standard Requirements for Instrument Precision Ball Bearings, B3.10-1960, has been approved and published by the American Standards Association. This revision supersedes American Standard B3.10-1959, and redefines the characteristics of instrument precision ball bearings. A table of metric series has been included in the 1960 edition which reflects the work in progress on international modifications through agreements reached on international levels.

Circle No. 204 on Subscriber Service Card.

SUBMINIATURE - SWITCHES — A subminiature-switch Catalog No. 20-1 containing complete information on the expanded line of Unimax subminiature switches. Listings include high-temperature, sealed, environment-free, and MIL-Specification type switches as well as popular styles of phenolic-cased, push-button, toggle, and integral-actuator subminiature switches, and is available from Unimax Switch Division of W. L. Maxson Corp.

Circle No. 205 on Subscriber Service Card.

SEMICONDUCTORS—A 4-color brochure describing the complete line of Motorola industrial and military semiconductor products is available from the Semiconductor Products Division. The 12-page brochure lists key specficiations such as breakdown voltage, current capacity, operating temperatures, and power dissipation of the products Motorola offers. These include germanium power transistors, audio and switching transistors, silicon and germanium Motorola Mesa transistors, silicon rectifiers, and silicon Zener diodes.

Circle No. 206 on Subscriber Service Card.

THERMOSTATS—A bulletin describing the line of Certified Type MX thermostats featuring narrow differentials is available from Stevens Manufacturing Co. The bulletin contains photographs and drawings as well as latest ratings on both semi-enclosed and hermetically sealed types.

Circle No. 207 on Subscriber Service Card.

MOTOR GENERATOR EQUIPMENT—A series of product bulletins covering 400 cycle motor generator equipment has been newly issued by the Precision Power Division, American Electronics, Inc. The bulletins cover a line of brushless inductor alternators giving complete specifications as well as application data. Power outputs from ½ to 30 KVA are available in a wide variety of designs.

Circle No. 208 on Subscriber Service Card.

EXTRUDER REFERENCE CHART—A chart which tells at a glance how to solve the problems which might arise in the extrusion of CYCOLAC$_R$ plastic, has been released by Marbon Chemical Division of Borg-Warner Corp. The chart covers items such as variations in dimensions, pulsations, lumps, rough surfaces or porosity, and sheet appearance.

Circle No. 209 on Subscriber Service Card.

METAL BONDED DIAMOND TOOLS—A catalogue published by the Fish-Schurman Corp. describes the firm's metal bonded, diamond impregnated products including drills, wheels, blades, dressers and hones.

Circle No. 210 on Subscriber Service Card.

# contracts

## NASA

$1,384,780—**Pittsburgh-Des Moines Steel**, for high-temperature structures tunnel.

## NAVY

**Vitro Laboratories**, for developing a standard procedure for measuring reliability of naval weapons systems. They are to establish a yard-stick for predicting how often, percentagewise, a missile system will fail to perform acceptably under specified conditions. Amount not disclosed.

$6,600,000—**Hughes Aircraft Co.**, Culver City, Calif., for production of inertial guidance system for the *Polaris* missile.

$3,000,000—**The Bendix Corp.'s Bendix Pacific Div.**, for antisubmarine warfare sonar equipment.

$70,000—**Davidson Optronics, Inc.**, West Covina, Calif., for grinding, polishing and testing the blanks for astrometric Reflector telescope.

## MISCELLANEOUS

**General Mills**, for development of a manipulator system to be used in remote handling of rocket fuels and rocket motors. Amount not disclosed.

$8,000,000—**Convair**, San Diego, for production of an advanced airborne mapping radar.

$3,000,000—**Cubic Corp.**, San Diego, for tracking system for the Sahara Missile Range.

$2,000,000—**Epsco, Inc.**, Cambridge, Mass., for telemetry development and manufacturing.

$1,381,105—**Fairchild Semiconductor Corp.**, Mountain View, Calif., for high-reliability transistors. Subcontract from **Autonetics Division of North American Aviation.**

$700,000—**Houston Fearless Corp.'s Uniconn Div.**, Los Angeles, for manufacturing gyros to be used in fire control systems. Subcontract from **Crosley Div. of Avco.**

$157,000—**Harvill Corp.**, Los Angeles, for die-cast components on a classified military project. Subcontract from **Aerojet-General.**

## ARMY

$30,766,492—**George A. Fuller and L. E. Webb, Los Angeles, and Paul Hardeman, Inc.**, Stanton, Calif., for launching facilities in Kansas for the *Titan*.

$16,800,000—**Sperry Utah Engineering Laboratory**, for production of *Sergeant* missiles.

$3,000,000—**Ford Motor Co.'s Aeronutronic Div.**, Santa Ana, for continuation of R&D of a *Shillelagh* weapon subsystem.

$1,600,000—**General Electric's Missile and Space Vehicle Dept.**, Philadelphia, for fabrication and test of airframes for the surface-launched free flight rockets and Automet test vehicles.

$1,352,000—**Sperry Rand Corp.'s Sperry Utah Engineering Laboratory**, Salt Lake City, for additional R&D on the *Sergeant* missile system.

$1,321,590—**Chrysler Corp.**, Detroit, for modifications on *Jupiter* missile components. (Two contracts.)

$1,077,438—**Chrysler Corp.**, Detroit, for engineering on the *Redstone* missile system.

$250,000—**Waltham Laboratories**, Waltham, Mass., for studying the feasibility of a field army ballistic missile defense system.

## AIR FORCE

**RCA** has received a "multi-million dollar" contract for development of a complete communication sub-system for the *Dyna-Soar* test program.

**Minneapolis-Honeywell Regulator Co.**, for first-phase development of the inertial guidance system for the *Dyna-Soar* vehicle. Amount not disclosed.

$23,500,000—**General Electric Co.'s Defense Systems Dept.**, for guidance system for the *Atlas*.

$12,000,000—**Stromberg-Carlson**, for communication systems for *Titan* bases.

$5,200,000—**International Business Machines Corp.**, for a central computer for the SAGE program.

$2,409,000—**Lear, Inc.**, Santa Monica, for automatic flight control system. (Two contracts.)

$2,000,000—**Boeing Airplane Co.**, Wichita, for *Atlas* missile site installation hardware.

$2,000,000—**Goodyear Aircraft Corp.'s Arizona Div.**, for overland *Atlas* missile trailers. Subcontract from **Convair.**

$1,700,596—**Sprague Electric Co.**, North Adams, Mass., for capacitors to be used in inertial guidance and flight control equipment for the *Minuteman*.

$800,000—**Telecomputing Corp.**, Los Angeles, for equipment used in conjunction with the *Minuteman*. Subcontract from **Autonetics.**

$750,000—**International Resistance Co.**, Philadelphia, for metal film units for the *Minuteman*.

$487,089—**Telecomputing Corp., Cook Batteries Div.**, for primary silver-zinc batteries to be used in flight control and guidance equipment of the *Minuteman*. Subcontract from **Autonetics Div., North American Aviation.**

$469,950—**The Wah Chang Corp.**, Albany, Ore., for metal extrusion equipment. Two contracts, one for tungsten extrusion and the other for tantalum.

$370,000—**Giannini Controls Corp.**, Duarte, Calif., for gyro systems for the *Titan*. Subcontract from **The Martin Co.**

$346,000—**Lockheed Aircraft Corp.**, Marietta, Ga., for additional missile scoring systems.

$90,000—**Lockheed Aircraft Corp.**, Burbank, for study aimed at determining the feasibility of logistics maintenance and support vehicles for space operation.

$78,000—**Hughes Aircraft Co.**, Culver City, for development of a micro-miniature instrumentation packet to measure man's physiological responses to space flight stresses.





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# M/R EDITORIAL COVERAGE OF GUIDANCE



**promotes product and capability sales to the $4 billion missile/space electronics market IN**

# missiles and rockets

## 4th ANNUAL ELECTRONICS ISSUE

**PUBLISHING DATE: FEBRUARY 27, 1961**
**CLOSING DATE: FEBRUARY 6, 1961**

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The current annual electronics market is estimated at $4 billion—guidance alone accounts for $1.5 billion. M/R is presenting a complete 40-page editorial round-up of military guidance systems, PLUS regular weekly features; news; developments. Major emphasis will be in these areas:

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- Guidance for satellite launch vehicles
- Guidance computer fabrication—radical technique used in development of Miniweld
- Analytical treatment of Dyna Soar guidance system
- Initial, mid-course and terminal guidance of Saturn boosted space vehicle
- First-time description of Minuteman guidance system
- All-inertial vs. radio command in ICBM systems
- Limiting problems and approaches towards gyroscope development
- Advanced guidance for solid-state computers in missile and space usages

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# names in the news



ZANE



GARR



DICKEY



LAW



WALKER

**Dr. Eric A. Walker:** President of Pennsylvania State University, elected to Melpar, Inc.'s board of directors. Dr. Walker succeeded **Dr. Milton Eisenhower** as President of Penn State in 1956. He fills the vacancy left by the resignation of **John A. Mayer.**

**Norman Kornetz:** Joins The Siegler Corp.'s Bogen-Presto Division as director of engineering. Was formerly manager of Commercial and Military Engineering at Westinghouse Electric Corp.'s Television and Radio Division.

**Dawes Walter** and **Richard S. Lee:** Named manager-advertising and public relations and assistant advertising manager, respectively, at Pennsalt Chemicals Corp. Walter was formerly with Atlantic Refining Co. and Lee moves up from sales promotion manager, Industrial Chemicals Div.

**Michael J. Joncich:** Former general sales manager of Datex Corp., elected vice president. Prior to joining the firm in 1953 he was a sales engineer with Minneapolis-Honeywell.

**John Zane:** Appointed to the reactivated post of advertising and public relations director for Cubic Corp.

**William Falstrom:** Former chief mechanical engineer with the Canoga Corp., elected president of Cubic Corp.'s newly organized subsidiary, TEMEC, Inc.

**Dr. Hector R. Skifter:** Elected to the board of directors of American Research and Development Corp., succeeding **Horace S. Ford,** who will continue as a consultant. Dr. Skifter is president of Airborne Instruments Laboratory, a division of Cutler-Hammer, Inc., and a vice president and director of Cutler-Hammer.

**John S. Harrison:** Senior flight test group engineer for the *Atlas,* named base activation administration manager for Convair-Astronautics Division of General Dynamics Corp.

**Dr. Trevor Law:** Former member of the Research Dept. at Bell Telephone Laboratories, joins Motorola Semiconductor Products Division as senior engineer.

**O. L. Lindahl** and **D. C. Webster:** Vice presidents of Librascope Division, General Precision, Inc., elected to the board of directors of GPI.

**John Huson:** Joins Reflectone Electronics, Inc.'s Washington office as staff member for advanced simulator and training equipment requirements.

**Donald E. Garr:** Former manager of engineering operations for General Electric Co.'s armament and control section, joins Raytheon Company as corporate director of engineering.

**Dale D. Myers:** Vice president of North American Aviation's Space and Information Systems division, named weapon systems manager of the *GAM-77 Hound Dog* program.

**Burton F. Drill:** Rejoins Schaevitz Engineering as director of marketing, having been previously associated with the company as sales manager. Prior to his return he was sales manager for systems and instruments for the Bulova Watch Co.

**Kendrick R. Wilson, Jr.:** Elected chairman of the board and chief executive officer of Avco Corp., succeeding the late **Victor Emanuel. James R. Kerr** succeeds Wilson as president and **Col. Earl H. Blaik** is now chairman of the executive committee.

**George J. Dickey:** Former assistant to the executive vice president, appointed vice president and assistant general manager of the Stromberg-Carlson division of General Dynamics Corp.

**Armand L. Klein:** Joins Pacific Electro Magnetics Co., Inc., as marketing manager. Was formerly manager of Ampex Corp.'s custom products division.

**J. N. Marshall:** Elected manager, Advanced Systems Development Engineering, for the Electronic Data Processing Division of Radio Corporation of America.

**Dr Alva C. Todd:** Former staff member at the Illinois Institute of Technology's Armour Research Foundation; joins The Hallicrafters Co. as director of applied research for military products.

**Dr. Edward H. Seymour:** Director of research for Thiokol's Reaction Motors Division, advanced to general manager of the division, succeeding **Raymond W. Young,** who will take over responsibility in formulation and guidance of technical programs as director of advanced planning.

**Charles A. Volz, Jr.:** Former vice president and general manager, elected president of Olympic Products Company, Inc., succeeding **Joseph B. Schaefer,** now chairman of the board of directors.

**Willis M. Hawkins:** Appointed a vice president of Lockheed Aircraft Corp., assigned to the Missile and Space Division. He will continue as assistant general manager of the division.

**Dr. Ben G. Forman:** Joins National Resistance Corp. as corporate and new products division director.

**Kenneth A. Waldron:** Former manager, Government and Industrial marketing, C.B.S. Electronics joins R F Products, a division of Amphenol-Borg Electronics Corp. as vice president, marketing.

**William B. Shimer:** Formerly with Chrysler Corp., appointed director of manufacturing services for Borg-Warner Corp.

**Charles W. Stephens:** Named associate manager of the Advanced Power Systems Division of Electro-Optical Systems, Inc. He joined the firm in 1958 as a senior engineer, and more recently served as assistant to the manager of the Energy Research Division. Earlier, he was engaged in auxiliary power system analysis and development at Space Technology Laboratories.

**Lowell Gene McClenning:** Former advertising-PR director at Benson-Lehner, joins Telemeter Magnetics, Inc. as director of public relations and advertising.

## Command Changes

*To the Editor:*

"So great a soldier taught us there
What long-enduring hearts could do
In that world-earthquake, Waterloo."

So wrote Tennyson, and with due respects to General Wilson's scholarly background, the soldier was Wellington. Marlborough had been dead for nearly a hundred years.

Leslie W. C. S. Barnes
Ottawa, Ontario

*To the Editor:*

It is indeed a pleasure to learn of the depth of scholarship which some of our military leaders have attained, particularly General Wilson.

However, if the Duke of Marlborough were ever at Waterloo (Quatre Bras, actually) which is doubtful, it is likely that his tactics were amorous rather than military.

The Duke, whose great victory at Blenheim (Hoechstaedt) took place in 1704, would have been in rather poor shape to have met Napoleon at Waterloo in 1815 (he died in 1722).

Scholarship is certainly a worthy end in itself. It is particularly gratifying to have a scholar in a research position, since the two are mutually complimentary *(sic)* but at this rate, *"Nunquam facibimus"* (literally, "We will never make it").

William L. K. Schwarz
La Canada, Calif.

*To the Editor:*

Re your "Scholarly General, detailing tactics of Marlborough at Waterloo is quite a trick. Where can this be seen? The Duke of M. must really have been "getting along in years" by 1815!

(Name indecipherable)
Ottawa, Ontario

P. S. Could a placed called Blenheim about the year 1704 be involved?

*M/R's brief profile of Lt. Gen. Roscoe C. Wilson, Air Force R&D chief, on page 13 of the Dec. 5 issue, said "he can explain in detail the tactics of Marlborough at Waterloo." However, General Wilson still gets A in history. The F goes to the chap who passed on the report to M/R, which trustingly refrained from going back to its history book. Wilson is pretty good on Marlborough at Blenheim, too.—Ed.*

A top expert on Russia tells why the Soviets lead in rocketry — and how we can close the gap now —

RUSSIA'S ROCKETS AND MISSILES

by Albert Parry
Contributing Editor,
*Missiles and Rockets*

One of the first experts to predict Sputnik I describes Soviet progress and potential —how Sputniks and Luniks were developed; latest status of East-West rivalry; contributions of German scientists to Soviet success; details about the Russian IRBM now being installed on Red submarines. *"Brings information that has not been available before."*—from the introduction by **WILLY LEY**

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## NASA's Space Exhibit

*To the Editor:*

Your views on the recent NASA exhibit in Montreal of U.S. space progress, as expressed in the M/R Dec. 5 editorial ("Exhibiting Our Space Achievements") are warmly appreciated. The fact that you speak as a professional communicator on the functional usefulness of good exhibits as a means of informing the world publics regarding the U.S. space science and exploration programs gives valuable authority to your statements.

In light of your remarks, I hope you do not feel that we are ungracious in noting for your attention the following:

A. Contrary to the impression one might receive from the editorial, NASA top management gave the exhibit project ready approval and prompt and adequate funding.

B. The exhibit is in no danger of ending its life with the showing in January in the Chicago Museum of Science and Industry. It will be available to qualified exhibitors as long as it lasts. Also, at least one additional exhibit along the lines of the Montreal presentation will start on tour in Fiscal 1961 and several copies of smaller exhibits will be made available for public showings. We have approved plans for material expansion of the NASA exhibits program in FY 1962, subject, of course, to availability of funds.

C. We are not at all unsure about accepting invitations to present NASA exhibits at the British Columbia Trade Fair in May and the American Rocket Society's New York meeting in October, 1961. We plan to show in Vancouver and are committed to a substantial exhibit at the ARS meeting.

Again, let me thank you not only for your appreciation of the value of such efforts as the Montreal exhibit but also for your tribute to its design and execution, which were the work of talented and dedicated public servants.

Shelby Thompson
Director, Office of Technical Information and Educational Programs
NASA
Washington, D.C.

*M|R did not mean to imply a lack of NASA management support for the exhibit, but rather a lack of funds; we are happy to learn of continuing support and showings.—Ed.*

## Irish Mist

*To the Editor:*

In the Oct. 24 M/R COUNTDOWN you state: "A major space research center for Western Europe is being established at Queen's University in Northern Ireland. The center is being built in cooperation with ARPA . . ."

This statement represents a very inaccurate picture of the actual contract with Queen's University, Belfast. Actually, the investigation to which you refer is being carried out under a U.S. Navy contract. The Advanced Research Projects Agency (ARPA) has made the funds available, but U.S. Navy personnel are responsible for the technical guidance and administration of the contract.

Projects which have been assigned to ARPA by the Secretary of Defense include those involving (a) military space technology, (b) advanced ballistic missile defense, and (c) *general science*. The projects fall into three categories: (1) research not identified with a specific military requirement, (2) research which relates to the primary functions of two or more military services, or (3) research which for other reasons is better handled by an agency other than one of the military services.

The contract at Queen's University is strictly a basic research contract, not identified with a specific military requirement. Studies are to be directed to the treatment of atomic and molecular processes by approximate methods. Absorption of X-radiation, electron capture, ionization by electrons and by heavy particles are some of the processes which will be studied. Much of the work involves tedious numerical calculations, hence a small digital computer is required.

To imply the establishment of a "major space research center for Western Europe" from this Queen's University basic research contract, therefore, is considered to be improper.

W. B. Heidt, Jr., Cmdr., USN
Director, U.S. Navy European Research Contracts Program
London

## The Real Echo?

*To the Editor:*

Page 13 of the Nov. 28 M/R states in

part, "The *Echo* vehicle has been visible for a few minutes during recent midnight passes . . . It should again be visible in about two weeks."

This is rather unsettling news if you mean the balloon itself. I have been observing early evening passes of an object I believed to be *Echo,* beginning the evening of Nov. 17-18 at 6:10 P.M. EST. The most recent sighting was the evening of Saturday, Dec. 3-4 at 6:10 P.M. EST. Times given here mean time when object was first seen upon rising and are probably accurate only to within a minute or two, as I have no special equipment. In all, 10 passes were observed on 7 evenings, as 2 consecutive passes were observed on 3 evenings. Those sightings which occurred after 7 P.M. were terminated when the object entered the earth's shadow, the position of the eclipse depending upon the time.

This object resembles the *Echo* balloon in its visual appearance and in its various trajectories across the sky. Five distinct and separately oriented orbital crossings have been observed. Also, the period between two consecutive appearances in one evening (2 hours) and its arrival on two consecutive evenings (now about 29 minutes earlier in 24 hours) resembles that of *Echo.* I know of no other orbiting object which has the same period and magnitude.

Would you please tell me: is the object I have been observing so diligently really *Echo?*

Joan Siedenburg
Cortland, N.Y.

*It very probably is. The news item meant that the balloon (that is, the vehicle) would soon be visible again during midnight passes. It has been visible during early evening passes for some weeks.—Ed.*

## Regulus' Record

*To the Editor:*

Just finished reading a bit about the phase-out of the Air Force's *Snark* after a total of 80 flights. In this era of exotic space probing it seems worthwhile to mention that the Navy's first operational submarine-launched missile, *Regulus I,* is still going strong with over 1000 launchings under its belt. This all-weather, rough and ready bird has been launched in desert-hot areas, from icy submarine decks and, in one specific instance, from a heavily rolling submarine in a State 5 sea (I know, because I launched it).

Reliability and performance have been noteworthy in this now-out-of-produciton Chance Vought missile, as compared with other surface-launched birds. Successful consecutive flights for the recoverable training version (FTM) have been consistently high, with, I believe, 20 flights the current individual record.

The Navy's *Regulus* Submarines (SSG's) are currently aiding in keeping the peace in the Far East from their base at Pearl Harbor and doing a mighty fine job of it.

R. E. Kutzleb
Key West, Fla.

# —when and where—

## JANUARY

**Symposium on Thermoelectric Energy Conversion, Joint Technical Society, DOD,** Statler Hilton Hotel, Dallas, Jan. 8-12.

**Seventh National Symposium on Reliability and Quality Control,** Bellevue-Stratford Hotel, Philadelphia, Jan. 9-11.

**International Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Jan. 9-13.

**Symposium on Space Instrumentation, IRE, PGSET,** Washington, D.C., Jan. 16-17.

**American Astronautical Society, Annual Meeting,** Sheraton Dallas Hotel, Dallas, Jan. 16-18.

**Winter Instrument-Automation Conference and Exhibit, Instrument Society of America,** Jefferson Hotel and Kiel Auditorium, St. Louis, Jan. 17-19.

**29th Annual Meeting, Institute of the Aeronautical Sciences,** Hotel Astor, New York City (Honors Night Dinner Jan. 24) Jan. 23-25.

**1961 Plant Maintenance and Engineering Conference, International Amphitheatre,** Chicago, Jan. 23-26.

**American Mathematical Society, National Meeting,** Willard Hotel, Washington, D.C., Jan. 24-27.

**Society of Plastics Engineers, Annual Technical Meeting,** Shoreham and Sheraton Park Hotels, Washington, D.C., Jan. 24-27.

**American Institute of Electrical Engineers,** Winter General Meeting, New York City, Jan. 29-Feb. 3.

**American Society for Testing Materials, Committee Week,** Netherland Hilton Hotel, Cincinnati, Jan. 30-Feb. 2.

**American Physical Society,** New Yorker Hotel, New York City, Jan. 31-Feb. 4.

## FEBRUARY

**Institute of Radio Engineers, Prof. Group on Military Electronics,** Los Angeles, Feb. 1-3.

**American Rocket Society, Solid Propellant Rocket Conference,** The Hotel Utah, Salt Lake City, Feb. 1-3.

**Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting,** Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, Feb. 26-Mar. 1.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

**Western Joint Computer Conference,** Los Angeles, Feb. 28-Mar. 1.


## Advertisers' Index


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# A New Boss for the Space Program

BY NAMING Lyndon Johnson chairman of the National Aeronautics and Space Council, Mr. Kennedy has in effect made the Vice President-elect responsible for the nation's space program.

Coming as it does, one of Kennedy's earliest major appointments, the designation of the country's No. 2 executive to the newly created post indicates two things clearly.

–The President-elect fully appreciates the importance of the U.S. space program and is determined to push it vigorously—as he said he would during his campaign.

–He wanted and has chosen a strong forceful man to head it.

As Chairman of the Senate Space Committee, Lyndon Johnson is thoroughly familiar with the strengths and weaknesses of our space exploration efforts. From the Congress he could only advise. From the executive branch he can direct, with the President's approval. And the Council—if it operates as the Congress intended it to operate—can decide whether or not we have a real space program, what its size and scope shall be, and who carries it out.

The Council is composed of the President, the Secretaries of State and Defense, the Administrator of NASA, one other selected federal official and three non-governmental members.

By executive action Mr. Kennedy has named Johnson his alternate on the Council, presumably to carry out all the duties enumerated. Some "tidying-up" legislation may be forthcoming to make this delegation of authority completely legal, but there is plenty of precedent for initiating it by executive action.

Under President Eisenhower the Council has met a few times to approve administrative matters but never functioned as the law intended.

For that matter, did President Eisenhower. In all fairness, however, it would have been unrealistic to expect the President of the United States to perform the detailed duties laid out for him in the Space Act. Our complaint with Mr. Eisenhower in this case is not that he failed to carry out the intent of the act—but that he failed to delegate the task to someone who would.

We have had, actually, not a space program but a space wrangle.

Now—if the President-elect is sincere, as we believe he is, in giving his No. 2 man a mandate to boost the United States into first place in the space exploration race—we can move along.

We can have a space program for peaceful purposes, but we can also quit pretending there is no military application in space.

We can carry out the projects designed to help all mankind and at the same time take the military action necessary to ensure that we have the freedom of space which will guarantee our right to explore peaceably.

Because human nature is as it is and because freedom must always be protected, the United States must have certain military capabilities in space—capabilities in reconnaissance, in defense, in offense and in support for all three.

At the moment we are working on only one —reconnaissance. We are dedicated to a "step-by-step" operation, except that some of the steps are missing.

To catch up we need a real and complete program which is understood by both government and industry. We need a great deal of basic and applied research in a joint effort—an effort which will permit us to move forward by quantum leaps instead of lagging steps. There is nothing lacking in the capabilities of the nation. The lack has been in the leadership.

**Clarke Newlon**

JANUARY 9, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY



olts on B-52 Mockup

Pressing Kennedy for Big Space Role ...
mmercial Space Communications Nearer
aris 'Fail-Safe' Launching System ..... 23

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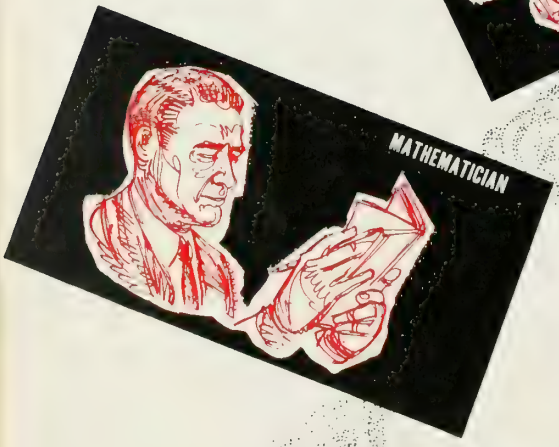
Space-Age Project "RELIABLE"

# A CHEMICAL EXPEDITION













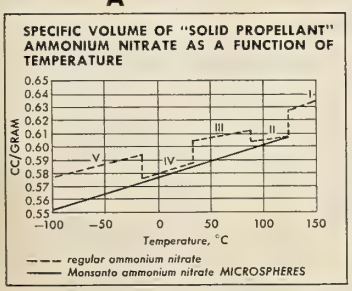


# probing the chemistry of nitrogen compounds ...develops new oxidizers that improve the efficiency and reliability of solid propellants

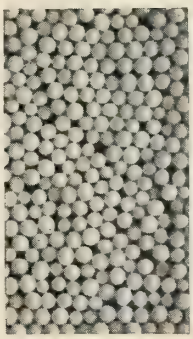
*Monsanto has developed "MICROSPHERES"—a new unique form of nitrate oxidizer that gives greater packing density, a more predictable burning pattern, and greater reliability to solid propellants. Most important, the oxidizer is low-cost, heat-stable, and forestalls cracking of the grain as the propellant mass burns.*

By applying advanced technology in physical chemistry to the problems of nitrate oxidizers, Monsanto has developed ammonium nitrate MICROSPHERES for solid rocket propellants. MICROSPHERES have a lower coefficient of expansion and a *linear* expansion with heat to prevent cracking of the "grain" upon temperature change. This oxidizing system is outstanding for improving reliability of production-line low- and medium-thrust solid propellants.

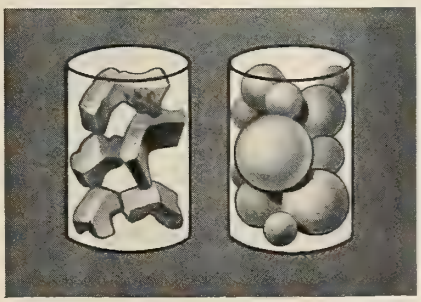
A




B



C



In contrast to high costs and handling hazards associated with other oxidizers, ammonium nitrate MICROSPHERES offer economy and safety. The new physical form increases the efficiency of the thrust and provides mechanical stability during manufacture, storage and burning.

Ammonium nitrate MICROSPHERES are an entirely new oxidizing entity for compounding solid propellants. Unlike ordinary ammonium nitrate, MICROSPHERES do not undergo expansion and contraction from crystalline phase changes, even with operational variation in temperature. (See Graph A.)

The MICROSPHERES make it possible to obtain a higher oxidizer loading for greater propellant efficiency. They are extremely dense. Small, round, and compact—MICROSPHERE particles each contain the greatest mass of chemical energy *per unit* of ammonium nitrate volume. (See Photo B.)

Tightly "packable"—the MICROSPHERES can provide the highest mass of chemical energy *per total volume* because graded sizes give the maximum density packing pattern. Even at a compound density of 1.72 grams per cc., ammonium nitrate MICROSPHERES can provide a *higher packing density* in the grain than commercial ammonium perchlorate at 1.95 grams per cc.!

Diagram C shows why and how MICROSPHERES pack to maximum density. On the left, approximately 34% void space results from using a five mode distribution of irregular-shaped oxidizer particles. On the right, only 15% void space remains with a five mode distribution of regular-shaped MICROSPHERES.

The volume relationship between round MICROSPHERES and irregular-shaped particles in mixed sizes remains approximately the same, regardless of the number of size ranges. Graded MICROSPHERE particle sizes, available in size distribution ranges that peak at 50, 200, and 300 mesh, offer maximum flexibility in controlling packing density. They effectively reduce volume to the minimum.

*(Please turn page.)*

With MICROSPHERES, less binder can be used to obtain better, more-reliable mechanical properties at a higher oxidizer loading. Unlike irregularly shaped particles, their smooth spherical shape does not cause areas of stress under "shaping" or burning deformation. They give better binder-to-oxidizer contact. With minimum plane-to-plane contact between particles, they greatly reduce the incidence of weak spots, cracking, and poor mechanical properties.

As a propellant oxidizer, ammonium nitrate MICROSPHERES offer many other benefits: good storage stability, safety from shock and thermal decomposition, uniform burning rate, smokeless exhaust, and low cost. Mixing of composite propellants is easier because their spherical shape reduces mass viscosity. They usually cut processing time and power input. MICROSPHERE grains are also easier to extrude or cast into the required geometric shapes.

## NEW OXIDIZERS FOR ROCKET PROPELLANTS
### ...a chemical capability of Monsanto

Project "Reliable"—which produced ammonium nitrate MICROSPHERES—is actively investigating other oxidizers for rocket propellants. Monsanto chemical "expeditions" are exploring nitrogen oxides, nitric acid, ammonium salts, and other nitrogen compounds. If you work with propellants, perhaps the materials you need for *your* project can be developed by Monsanto. Write or call: Monsanto Chemical Company, Department MR, C Building, St. Louis 66, Missouri.




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THE MISSILE / SPACE WEEKLY

# missiles and rockets

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## THE COVER

*Full Scale models of the Air Force's Skybolt ALBM were shown for the first time last week on a B-52 wing mockup at Boeing's Wichita plant. (AF photo)*

## JANUARY 9 HEADLINES

AF Drives for Big Space Role ..... 11
How New AF Chief Plans to Push Decisions ..... 12
Commercial Satellite Given Go-Ahead ..... 13
NASA Lists 36 Major Space Shots for 1961 ..... 14
NASA Stretches Out Space Program ..... 15
'Private Ocean' for Polaris ..... 16
Solar Flares Pose Shielding Problem ..... 18
Engineers Have 'Inferior' Feeling ..... 34
Hoegh Disputes Military CD 'Takeover' ..... 40

## ELECTRONICS

SLAG Makes Polaris Firings 'Fail-Safe' ..... 23
IBM's New Cryogenic Memory Planes ..... 25
Autonetics Unveils Minuteman Computer ..... 29

## ASW ENGINEERING

Seismology Takes to Undersea Warfare ..... 28

## ADVANCED MATERIALS

High Temperatures Foiled by Foam ..... 30
Huge Press to Make Record Forgings ..... 32

## PROPULSION ENGINEERING

Supersonic Burning Probed ..... 33

## INTERNATIONAL

Swedes Develop Versatile Air Rocket ..... 36
Radar Sighting System Unveiled ..... 37

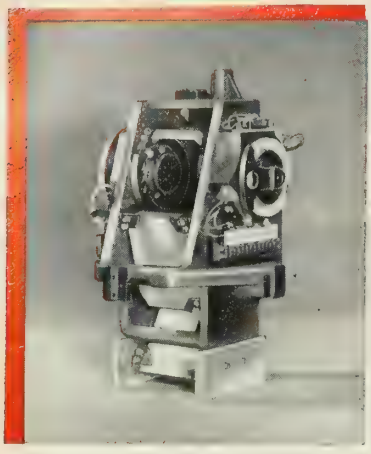
## DEPARTMENTS

The Missile/Space Week† ..... 6
The Countdown ..... 9
Technical Countdown . 21
Industry ..... 38
Editorial ..... 50
Products & Processes .. 42
Contracts ..... 46
Names in the News ... 47
Letters ..... 40
When and Where .... 49

†U.S. Reg. Pdg.

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**PRECISE STAR TRACKER**



A celestial navigation system called for a tracking device capable of establishing a line of position within an accuracy of 300 feet. Kollmorgen came up with a constant deviation elevation system that positions a movable mirror, in relation to the fixed elements, to a repeatable accuracy of better than 5 parts in a million.

This compact package represents a combination of highly precise optical and electronic units in a housing only 6 x 6 x 10 inches. Kollmorgen's project from concept to installation, it is a typical demonstration of the company's scientific, engineering and manufacturing skills in optics, electronics, mechanics. Example: the precision optics (a prism and two mirrors) are of Kollmorgen manufacture. So, too, are the Inland torque motor*, the gearing and other precision-machined parts.

Our motive in this message: Kollmorgen offers proven capabilities in optics, electronics and precision machining of metal components . . . capabilities which could solve your problems in missile tracking, fire controls, navigation, or . . .?

**Present us with a problem.**

*Product of Inland Motor Corporation of Virginia, a Kollmorgen subsidiary.

Dept. 6-1

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# The Missile/Space Week

## Titan II Funding Investigation Coming

A new "who struck John" fight is brewing over alleged delays in the scheduled deployment of the Martin *Titan II*.

The General Accounting Office is charging in a secret report to Congress that apparently unjustified withholding of funds will delay deployment of the storable-propellant *Titan II* five months.

However, Pentagon sources indicate that funds were withheld because of R&D problems and indecision about whether to move *Atlases* instead of *Titans*.

The first *Titan I* squadron is scheduled to be operational this summer. The first *Titan II* squadron has been scheduled to be operational by early 1963. The GAO report was sent to several House and Senate Committees. More is expected to be heard of the matter shortly.

## Red Space Spectacular for Kennedy Inauguration?

Informed scientific guesstimates in London schedule a new Soviet space launching to coincide with the inauguration of President-elect Kennedy.

News reports quote "western intelligence" as indicating that the Russians will either land a robot laboratory on the moon or launch a manned spacecraft into orbit around the earth. Unusual activity is reported to be taking place at Red satellite launching pads. Moreover, Russian range ships are reported to be preparing to put to sea.

Meantime, for the record, Tass boasted as the New Year began that *Lunik I* has travelled one billion miles since it was launched into a solar orbit on Jan. 2, 1959.

## Polaris: 32 Birds on Station

The Navy began the New Year with two *Polaris*-launching submarines somewhere in the sea within striking distance of the Soviet Union. Three more *Polaris* subs are scheduled to join them on station before the year is out.

The deployment of the Patrick Henry—second of the *Polaris* fleet—on Dec. 30 from Charleston, S.C., brought to 32 the number of 1200-mile range Lockheed *Polarises* in the nation's strategic forces. The first *Polaris* sub—the George Washington—sailed Nov. 15.

The Navy had pledged earlier that both ships would be on station by the end of December.

## Telescope To Observe Stars from Fringe of Space

U.S. scientists are planning to photograph the heavens with a balloon-carried telescope capable of distinguishing two oranges a foot apart at a distance of 500 miles.

The 36-inch telescope is scheduled to be launched 15 miles above the earth next fall—a forerunner of the first orbiting space observatory. The telescope system weighs 4300 pounds.

Scientists hope to obtain the first photos of the clouded surface of Venus along with data that will explain the birth of stars. The project—called Stratoscope II—is under the direction of the National Science Foundation, the Navy and Princeton University.

## Excess Profits Hit Eight-Year Low

The Renegotiation Board has told Congress that 1960 excess profit findings were the lowest in eight years.

The board's annual report disclosed findings of $52,708,003 in excessive profits—$15,923,346 of which were settled by mutual agreement between the government and manufacturers.

Of the board's 108 determinations of excessive profits in fiscal 1960 70 were settled with bilateral agreements. The 38 others, resulting in orders for refunds, included five airframe manufacturers with renegotiable sales of $3,102,000.

The board issued claims of $20,400,000 in excess profits against the five companies who have appealed their cases to the Tax Court. Claims against the aircraft firms represented 55.6% of the dollar volume represented in the unsettled 1960 cases, the board said.

From fiscal 1953 through 1960 the board made total refund claims of $836,520,934. In addition, voluntary refunds and price reduction by contractors amounted to $1,111,675,277. Allowing for the tax credit, the net recovery to the government is $742,500,000, the board said. Voluntary price reduction in fiscal 1960 alone reached $77,812,876.

Of 272 unilateral orders that had been issued by the board through June 30, 1959, 85 had been appealed to the Tax Court. Another 12 were appealed in fiscal 1960, 10 of which were disposed of in the same year. Some 62 cases were still pending as of June 30, 1960, including 19 by major airframe manufacturers, 43 by others. Aggregate determination of the excess profits involved is $109,847,208.

### Pershing and Zeus Hold top Contract Spots

Army contract awards to Martin for the *Pershing* missile system have put the company in the No. 2 slot on the Army's major contract list for FY 1961.

The Army and Martin this last week signed a *Pershing* contract totalling $138,489,470 running through the current fiscal year. The contract represented $76,921,772 in new money. Martin already had received $61,567,698 in previous awards for *Pershing* for FY '61.

The only bigger contract awarded so far this year by the Army was to Western Electric last September for *Nike Zeus*. That came to $199,125,000.

### Please Don't Tell the Kremlin

The Air Force is asking contractors not to reveal the precise locations of *Minuteman* launching sites.

"We've been criticized too much for revealing the exact locations of missile launchers," a spokesman said this last week.

However, he did not make any suggestions of how contractors were supposed to hide the holes in the ground.



### Davy Crockett Takes a Bow

The Army this last week showed off its previously highly-secret *Davy Crockett* nuclear warhead.

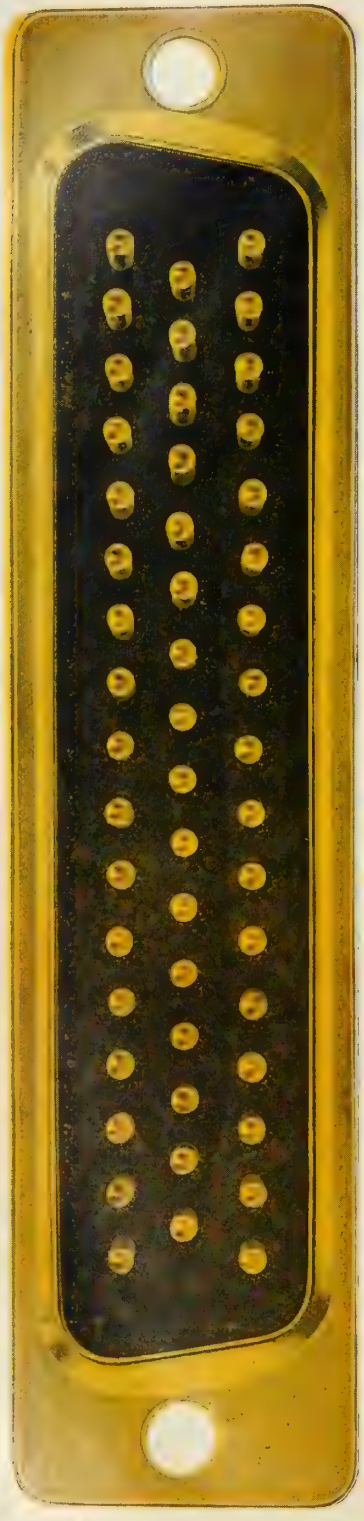
It looked for all the world like a miniature model of the 10,000-pound "Fat Man" atomic bomb that was dropped on Nagasaki more than 15 years ago.

Unlike the "Fat Man," *Davey Crockett* is light enough for one man to carry it under his arm. However, in the words of Army Secretary Bruckner, it "dwarfs in firepower anything we have ever known in the immediate area of the battleline." An Army statement said *Crockett* "gives small units of firepower heretofore obtained only from massed artillery."

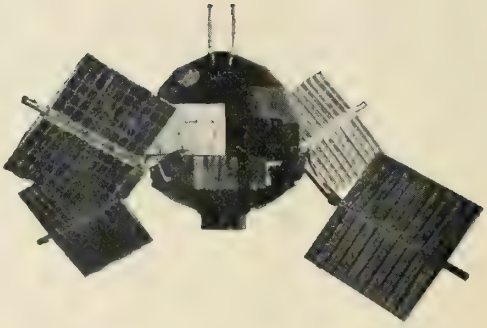
*Crockett* can be fired from jeep-mounted or man-mounted launchers that provide a wide variety of ranges. The same warhead is used for both launching systems. *Davy Crockett* is manufactured at the Army's Rock Island Arsenal. The new missiles are expected to be deployed by summer.




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# The Countdown

## WASHINGTON

### Will Congress Count Missiles or Dollars?

Congress has yet to determine how it will implement its new policy of authorizing as well as appropriating funds for the procurement of missiles and aircraft. The big question is whether to set the precedent of doing it by numbers of missiles or numbers of dollars. Many congressmen would prefer to do it by numbers of missiles to maintain tighter control.

### Atlases A-coming In

COUNTDOWN hears contractors are quietly turning over to SAC a sizeable number of *Atlas* launchers. An announcement that more squadrons are operational is expected soon. At present the announced number still stands at two—one six-bird squadron at Vandenberg, the other at Warren.

### A Break for Mercury

Both the House and Senate Space Committees appear to be adopting a be kind to Mercury policy—at least for the present.

The two committees tentatively are putting off taking a hard, public look at NASA's plodding man-in-space operations until the new Kennedy Administration decides what it wants to do in space.

### Mobile ICBM: Technically Looks Good

Army experts close to FABMIDS—the mobile field anti-missile missile under study—say the technical problems associated with the project look easy compared to ICBM defense. The reason: FABMIDS would be used against missiles launched close enough to use their heat plumes as a target, killing them during their boost phase.

### Nike-Zeus: Testing Sooner Than Expected

The official date still being given out for the full *Nike-Zeus* tests against *Atlases* launched from Vandenberg AFB is 1962. But this is the public opening performance. Some dress rehearsals are expected out in the uncrowded Pacific later this year.

### Bobby Lee Returns to the Watery Pad

Third of the *Polaris* fleet—the nuclear powered submarine Robert E. Lee—is about to begin another series of underwater training launches off Cape Canaveral. Then she will undergo some final adjustments and head for her station off the Soviet heartland probably in time to relieve the Patrick Henry. (See p. 6.)

### Gen. White May Stay On

There's speculation that AF Chief of Staff Thomas White may stay on for a third term. He's highly regarded by Kennedy and some members of Congress.

### From the Pad

Second *Mercury-Redstone,* which will carry a chimp on a ballistic flight, is set for the week of Jan. 17. But, it's agreed that if there is any slippage the shot won't go on Jan. 20—Inauguration Day . . . NASA is set to launch S-45, an ionosphere beacon satellite resembling Explorer VIII, about Feb. 1.

## INDUSTRY

### Atlas G Proposed

There's support from the House Space Committee for a Convair proposal to upgrade *Atlas* into a 900,000 lb. thrust space booster. The *Atlas G* with a *Centaur* upper stage would have a 4000 lb. payload capability, be able to lift *Dyna-Soar II.* Cost of development is estimated at $85 million; time—about two years. But, there are still no firm plans to work such a booster into the space program.

### Fast Tax Write-offs Backed

Look for possible favorable action by congress on a Kennedy-backed plan to give business a stimulant by reviving some form of rapid tax amortization. More than 2000 firms have already informed the Treasury that liberalized depreciation allowances would make them increase capital expenditures for expansion. Defense industry R&D facilities presumably would be included in any new legislation.

### Jackets for Missiles

AF BMD is still pursuing a study of means to keep cryogenic missiles permanently loaded with fuel and oxidizer in "ready-to-fire" state. Contractor is Linde Co., and the study may involve use of refrigerated jackets (M/R, Sept. 21, 1959, p. 35).

### Air to Space Guidance

Hughes Aircraft is developing an advanced version of the sidelined F-108 fighter's guidance and control system for limited use in space.

### Saturn Booster Getting Ready

Static tests of the first flight model *Saturn* 1.5 million lb. thrust booster are expected to start next month. After qualification and any necessary modifications it will be shipped by barge to Cape Canaveral for first launching, expected this year.

## INTERNATIONAL

### Sahara Missile Range Extension

French are planning to extend their Sahara Missile Range (Colomb-Bechar) to 10,000 miles. Equipment already is on order. Some of it also will be used for the test and evaluation later this year of the NATO *Hawk* anti-aircraft missile.

### Blue Streak Decision Nears

Upcoming London conference on a joint European space program probably will result in a make-or-break decision on going ahead with the cancelled *Blue Streak* IRBM as a basic booster. French are cool towards *Blue Streak,* largely because no money is available. Even an offer to substitute the French Veronique for the English Black Knight as the second stage has aroused no "Vivas" in Paris. Germany's reactions to British plans may be the key to the whole idea.

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*System Development Corporation, Santa Monica, California, Paramus, New Jersey.*

SDC



*Massive campaign . . .*

# AF Drives For Big Space Role

## *Kennedy is being urged to reverse Ike; make space top card*

**by James Baar**

The Air Force is preparing a powerful campaign to convince the new Administration and Congress that a large scale program aimed at military control of space must be started immediately.

A series of highly-classified briefings have been prepared for the new Defense officials being appointed by President-elect Kennedy. Similar briefings are ready for presentation to various committees of the House and Senate within the coming weeks.

The conclusion pointed to by all of them is that the Eisenhower Administration policy of hobbling U.S. military space efforts should be reversed. The companion conclusion is that the United States must begin spending large sums of money to implement the policy change.

Both of these conclusions run sharply counter to the forthcoming final Eisenhower defense budget which will be sent to Congress Jan. 16. However, the Kennedy Administration is expected to make radical alterations in defense spending in line with campaign promises. These would come either in a supplemental defense money bill, amendments to the FY '62 budget or both.

The strategic thinking behind the Air Force campaign for a large space role is basically that control of space is expected to be the coming top card in the East-West power struggle.

The time period when such a top card might be played would be in the late 1960's and early 1970's. However, in order to have such a card ready, work must begin now.

Air Force officials hope to begin developing offensive and defensive military space systems on a top priority basis as quickly as possible. However, one of the most vital main goals is expected to be—not a weapon—but a means of drastically cutting the cost of placing a space system in orbit.

At present, the cost of placing one pound in orbit is approximately $1000. Air Force officials want to reduce the figure to $100 or less.

As one put it: "The first fellow that can cheaply begin putting up a man and a boy with something to drop is going to be the fellow who is way out ahead."

This line of thinking may or may not lead to a spacecraft like ASP—the proposed aerospace plane that the Air Force has under consideration. The answer might be a recoverable booster or any one of a number of other proposals being advanced by the Missile/-Space Industry.

The Air Force, in pressing for a big military space program, is confronted with a series of difficult obstacles.

Cost is among the biggest. Billions would be needed over the next few years. This kind of new spending must either come out of the hide of other programs and military services or boost appreciably the defense budget.

• **AF versus NASA**—Another major problem is the present lack of appreciation of the threat.

The entire history of the Cold War is a series of U.S. responses to Russian activities. So far the Soviet military men who are conducting the Russian space program have been able to sugarcoat their activities sufficiently to avoid alarming too many Americans unduly. If Laika had worn a sidearm, the entire U.S. space operation to date probably would have been different.

The third major obstacle is the effect of the repeated insistence by the Eisenhower Administration that U.S. policy is to explore space for peaceful purposes coupled with repeated statements that the military has a narrow mission in space at the most. It is well known that these policies have been implemented by the generous deletion by Eisenhower Administration officials of references to military space operations in Pentagon speeches.

As a result of these policies, the major space assignment was given to NASA with limited funds to support it. To meet this assignment NASA has created a sizeable coast-to-coast organization in anticipation of large scale future operations. However, if the Air Force launches a large scale space program, many of the programs planned by NASA would become duplication.

Thus, in the tradition of established government, many NASA officials and supporters can be expected to oppose the attempted entry of military programs into the field.

The strategic space threat to the United States as seen by many military men has its roots in the classic military struggle for access to the enemy's territory.

Control of space would give the Soviet Union access to any point on earth. Conversely, control of space could give the same great advantage to the United States.

Great strides toward developing manned military space systems have already been made by the Soviet Union. The launching into orbit of a five-ton manned Soviet spacecraft has been considered imminent for several months. Some reports have indicated that the Soviet spacecraft will be a winged vehicle somewhat similar to the Air Force's *Dyna-Soar*—a program still in the early R&D stage and far from liberally funded.

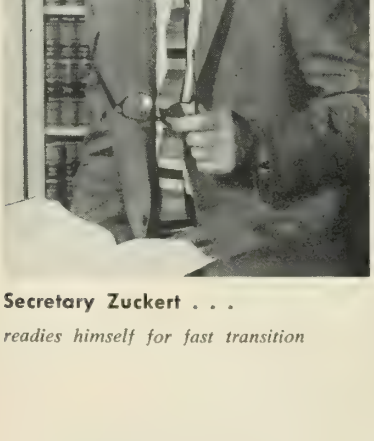
The Russians long ago disclosed their timetable: They plan to be on the moon by October, 1967.

Few U.S. rocket experts have expressed doubts that the Russians can be there on time.



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# How New AF Chief Plans to Push Decisions



**Secretary Zuckert . . .**
*readies himself for fast transition*

**by Clarke Newlon**

A FAST TRANSITION into the technological intricacies of the military space age will be the major task confronting Eugene C. Zuckert when he is sworn in as Secretary of the Air Force.

The Washington attorney served as assistant secretary of the USAF from 1947 to 1952. From 1952 to 1954 he was an Atomic Energy Commissioner. In the six intervening years the world has moved a long way over the threshhold of military space operations.

In preparation for this transition Zuckert last week began a series of intense briefings to bring himself up to date. Early in the week he spent time at the Pentagon where he heard presentations by Under Secretary Joseph Charyk and teams of the Air Council.

Thursday he was to leave on an indoctrination tour which would include visits to Wright-Patterson Air Force Base, Air Force Procurement Center; Strategic Air Command Headquarters at Omaha and the Ballistic Missile Division at Los Angeles. On route he will stop at North American Air Defense Command and the Air Academy at Colorado Springs.

After his return he will spend a day each at Tactical Air Command Headquarters, Langley AFB, and at the Air Research and Development Command, Andrews AFB.

• **New positions**—Many of Zuckert's plans for the personnel of the top Air Force civilian office are already made.

Dr. Charyk will remain as under secretary and will double as assistant for research and development, with a wider scope of operations and responsibility.

Lyle S. Garlock will remain on as assistant secretary for financial management.

Max Golden will remain as General Counsel.

John J. McLaughlin will continue as administrative assistant, a post he has held through all AF Secretaries.

An assistant secretary for procurement will be named. Air Force procurement, Zuckert believes, is one of the service's vital departments and he is seeking a strong man for this post—a man he has been unable to find.

Two other special assistants will be appointed. One is for installations. Two men are under consideration for this spot.

The second is to be special assistant for public affairs, a new office created to assist Zuckert with his responsibilities for the Air Force Office of Legislative Liaison and the Office of Public Information, both headed by major generals. Zuckert has selected the man for this job but does not wish to make an announcement until after the inauguration.

Realizing that during the first six months, much of his time will be taken up with appearances on Capitol Hill, Zuckert plans to lean heavily on his assistants. Particularly is this true of Charyk and the other holdovers.

• **Making decisions**—He plans to transpose the many problems confronting the office into projects, with project officers responsible for fast solutions and decisions.

One of the points President-elect John Kennedy made during his campaign in reply to M/R's Open Letter (M/R Oct. 3, 1960) was the necessity of restoring decision-making to defense and space problems.

Like his big boss, Gene Zuckert is acutely conscious of the need for taking action. He would prefer that he and his subordinates make mistakes occasionally than that they delay decisions for fear of not being absolutely right.

Two key jobs on his personal staff which Zuckert must fill are those of legislative liaison and public information. The legislative chief is Maj. Gen. Thomas C. Musgrave and chief of information is Maj. Gen. Arno Luehman.

Musgrave has held his post since September, 1959, and Luehman since May, 1957. Both are expected to continue until early summer when the present term of Gen. Thomas White, AF Chief of Staff ends. At that time Musgrave may stay on but Luehman, after four years, will probably be reassigned.

The second term of White as Chief of Staff ends June 30 and at this time a selection must be made to fill both this place and the job of vice chief, presently held by Gen. Curtis LeMay. While the Chief of Staff is a presidential appointment, the Air Force Secretary will certainly have a large voice in the appointment.

In the Air Force four-star ranks are Generals LeMay, Laurence Kuter, Thomas Power, Frederic Smith, Frank Everest, Samuel Anderson, Emmett O'Donnell and Lauris Norstad. Any might be named, with the probable exception of Norstad who has been in ill health and wishes to retire. There is also the possibility of dipping down into the three-star rank. ■

*White House Order . . .*

# Commercial Satellite Given Go-Ahead

***NASA to start R&D on active-repeater communications satellite; FCC preparing to grant experimental channels temporarily to AT&T***

**by Jay Holmes**

COMMERCIAL COMMUNICATIONS satellites are moving closer to reality on two fronts.

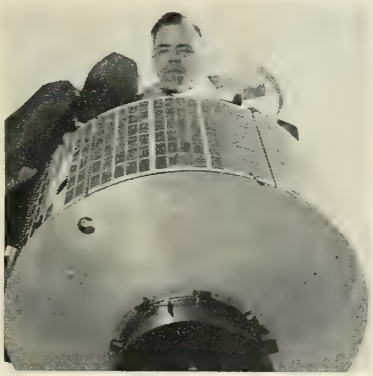
President Eisenhower ordered the National Aeronautics and Space Administration last week to take the lead in the Executive Branch of government to carry out R&D and to encourage private industry to apply its resources toward the earliest practical use of space technology for commercial communications.

NASA promptly arranged for a two-day industry briefing at which it will ask for bids on developing a real-time active repeater satellite for flight within two years.

Meanwhile, the Federal Communications Commission prepared to award the American Telephone & Telegraph Co. temporary licenses to operate transmitters on the ground and on a satellite for experiments in long-range communications.

The President said NASA will cooperate closely with FCC to make sure that high communications standards are maintained in using satellites. He called for concerted action and funding on the part of both government and private enterprise in this country and communications organizations in other countries.

James C. Hagerty, Eisenhower's press secretary, was asked what effect the change of administration would have on the policy statement by the President. Hagerty replied that Eisenhower's executive order will stand as the policy of the government unless and until changed. He said there had been no consultation on the subject with the incoming Kennedy administration. Dr. Hugh L. Dryden, deputy NASA administrator, added, however, that the congressional space committees were informed.



*COMMUNICATIONS SATELLITE developed by Hughes for 24-hour orbit weighs 32 lbs.*

• **20 companies involved**—It is understood that the new administration will review the Eisenhower policy statement along with its planned complete review of the nation's space program. However, there does not appear to be any wide-spread sentiment for immediate modification. Space advisers to the new administration are convinced as much as the old administration that operation of commercial communications facilities must remain in private hands.

Twenty companies will be invited to the briefing to be held by NASA's Goddard Space Flight Center, Greenbelt, Md. They are AT&T, Lockheed Missiles and Space Division, Ford Aeronutronics Division, Republic Aviation, Avco Research and Advanced Development Division, Western Electric Radio Division, International Telephone & Telegraph Corp. Federal Division, Bendix Systems Divisions, Hughes Aircraft, Motorola, RCA Astro-Electronic Products Division, the Martin Co., Collins Radio, General Dynamics' Convair Division, Page Communications Division of Northrup Corp., North American Missile Division, Grumman Aircraft, McDonnell Aircraft and Loral Electronics.

Goddard tried to set the briefing for Jan. 4 and 5, but specifications could not be prepared in time. It is expected to be held this week or next.

Dryden said NASA wants to develop real-time active repeater satellites weighing 100 lbs., using solar power, which would be launched into orbits varying in altitude from 3000 to 6000 miles. He said such a satellite, using an omnidirectional antenna, would need no attitude controls. A system of 25 to 40 satellites would provide complete coverage for 600 telephone channels or one television channel.

The first satellite could be launched in 18 months to two years by a *Delta* vehicle, Dryden continued, but multiple launchings would be necessary to bring down the cost of the satellite system. The biggest problem in R&D is the lifetime of electronic components, such as solar cells, in space. He recalled that the Army's *Courier 1B* communications satellite quit operating a few days after launching last Oct. 4.

For comparison, the NASA official also outlined the characteristics of two other communication satellite systems under active development, the *Echo*-type low-altitude passive communications satellite, being developed by NASA, and the synchronous 24-hour active repeater satellite, being developed by the Department of Defense under Project *Advent*.

• **Quick Echo**—The next *Echo* will have a 140-ft. diameter, weigh 600 lbs., and will be launched to an altitude of 1500 to 2000 miles. A world wide system of *Echo* satellites would require 60 to 100 of them, distributed in several planes at random. To lengthen the satellites' life, the skin must be stiffened somewhat.

Dryden believes an *Echo*-type system can be achieved very quickly but its utility will be limited because of the

narrow channel width—wide enough for voice, telegraph and transmission of still pictures, but not wide enough for telegraph.

The 24-hour satellite might weigh 1200 lbs., be powered by solar cells and travel in a circular equatorial orbit of 22,300 miles altitude. It would require a directional antenna and attitude controls, to keep the antenna pointed toward the earth. A system of three satellites would provide from one to four television channels or an equivalent bandwidth for voice and telegraph channels.

Dryden said the 24-hour satellite characteristics were the result of a NASA study. He emphasized that they are not necessarily the exact characteristics of the *Advent* satellites.

Robert G. Nunn Jr., NASA assistant general counsel who has been specializing in communications problems, said one TV channel requires 4½ to 5 megacycles bandwidth and equals 600 voice channels. A voice channel is about equal to 20 telegraph channels.

Hagerty, who is expected to join the American Broadcasting Company after Jan. 20, predicted that if communications satellites R&D is pressed, it will be possible to receive live TV coverage from the 1964 Olympic Games in Japan. Dryden estimated that a system of satellites and ground stations would cost $60 million to $100 million to establish. He said this is about half the cost of laying underwater cables with the same capacity.

The major economic problem for communications satellites will be similar to that of operating jet airliners, Dryden declared. The full capacity must be used. Eisenhower, in his statement, said the world's requirements for communication facilities will increase several fold during the next decade.

• **Some opposition**—The AT&T application before the FCC asks for permission to construct a 3000-watt station that would transmit to the satellite from Holmdel, N.J., in the 6775-6875 megacycle band and a 5-watt transmitter that would operate aboard the satellite in the 6425-6525 megacycle band. The company said it expects to complete construction within eight months after grant of permission to proceed.

FCC sources indicated that the application was being worked on very actively late last week and a decision could be expected at any time. Neither hearings nor meetings of the full commission are necessary for action on requests for experimental stations.

Some opposition to the request has been put before the FCC but indications are that the license will be granted nevertheless. At the White House press conference, Dryden said he understood the FCC viewed the application favorably.

The opposition may be heeded, however, with respect to the AT&T request that the entire 6425-6925 megacycle band be set aside for satellite communications. The latter request has drawn opposition from 10 organizations representing companies interested in developing private point-to-point microwave communication systems. All suggested that the FCC defer consideration of the request until it takes up its long-range study of frequency requirements for space and earth-space communications, for which interested parties are to reply by March 1.

Opposition to the AT&T application was filed by American Waterways Operators Inc., Forest Industries Radio Communications, Electronic Industries Assn., American Petroleum Institute, National Retail Merchants Assn., Aeronautical Radio Inc., Assn. of American Railroads, Motorola and the National Committee for Utilities Radio.

Most opponents argued against the principle of sharing frequencies between space communications users and those on the ground. They suggested, instead, that channels for space communications be taken from those already allocated to common carriers, such as the 5925-6525 megacycle band.

AT&T replied that sharing between space communication systems and the long-distance common carrier services of bands such as 3700-4200 mc and 5925-6425 mc "would result in the imposition of limitations in the use and capacities of these microwave radio systems," used for long-distance telephone service. ⌗

# 1961 Launches

## NASA Schedule Lists 36 Major Space Shots

The National Aeronautics and Space Administration plans 36 major launches in 1961, beginning with a chimpanzee-carrying *Mercury Redstone 2* this month.

The year's schedule calls for 16 *Mercury* shots, 14 unmanned satellites, 5 space probes and first launching of the mighty *Saturn* booster.

In the *Mercury* schedule are one *Little Joe,* six *Redstone* and nine *Atlas* launchings, of which six or seven will be attempts at orbit. The number of empty capsules launched into orbit, followed by capsules carrying chimpanzees, will depend on developments. The timing and sequence of the first manned shot is of course even more conjectural.

Unmanned satellite shots include three *Juno II's,* winding up that program, five *Deltas,* three *Scouts* and three *Centaurs,* aiming at 24-hour orbits. The most interesting satellites are *S-16,* the *Orbiting Solar Observatory,* to be launched by a *Delta* vehicle in the second quarter; the third *Tiros,* to be launched by a *Delta* in the third quarter, and *S-15,* the gamma ray astronomy satellite, to be launched by a *Juno II* in the first quarter.

Space probes include *P-14,* a magnetometer experiment to be launched by a *Delta* in the first quarter, *P-32* and *P-33,* the first two *Ranger* spacecraft tests, to be launched by *Atlas-Agena B* vehicles in the final two quarters, and *P-21* and *P-21a,* a pair of electron density experiments to be launched by *Scouts* in the third and fourth quarters.

Here is the tentative schedule:

### First quarter

**Mercury MR-2, bearing a chimpanzee; January**
**Ionosphere beacon S-45, Juno II**
**Mercury MA-2**
**Little Joe 6 (repeat of LJ-5)**
**Interplanetary P-14, Delta 4**
**Mercury MR-3 (manned if MR-2 goes well)**
**Mercury MA-3**
**Air density drag S-56, Scout 4 (repeat of Scout 3)**
**Mercury MA-4**
**Gamma ray astronomy S-15, Juno II**

### Second quarter

**Mercury MR-4, (presumably second manned shot)**
**Mercury MA-5**
**Orbiting Solar Observatory S-16, Delta 5**
**Micrometeorite S-55, Scout 5**
**Mercury MR-5**
**Backup Juno II**
**Mercury MA-6**
**Radiation belt S-3, Delta 6**
**Vehicle test, Centaur 1**

### Third quarter

**Backup Scout 6**
**Mercury MA-7**
**Mercury MR-6**
**Electron density probe P-21, Scout 7**
**P-32, (Ranger 1), Atlas-Agena**
**Mercury MR-7**
**Tiros 3, Delta 7**
**Mercury MA-8 (this could be the manned orbital)**
**Vehicle test, Centaur 2**
**Saturn 1 (dummy 2nd and 3rd stages)**

### Fourth quarter

**Electron density P-21a, Scout 8**
**Mercury MA-9**
**Backup Delta 8**
**P-33 (Ranger 2), Atlas-Agena**
**Mercury MA-10**
**Atmospheric structures S-6, Delta 9**
**Vehicle test Centaur 3**

# NASA Stretches Out Space Program

***Planetary exploration is moved back to 1964—2-year delay unless Kennedy acts, Rover nuclear rocket also will slip to 1966-67 period***

MAJOR STRETCHOUT of the U.S. Civilian space program has been added to the problems left with the Kennedy administration by the outgoing Eisenhower team.

Administrator T. Keith Glennan of the National Aeronautics and Space Administration ordered the stretchout and announced it together with his resignation, effective Jan. 20. While lowering the nation's sights, he said America is "once again preeminent in the conduct of research and development."

Eisenhower, in a "Dear Keith" letter, replied that under Glennan's leadership NASA has "compiled a record of achievement of which every American can be justly proud."

By late last week, Deputy Administrator Hugh L. Dryden had given no indication of his plans. It was understood that Dryden will be available to the new administrator to assist him in the transition period.

Dryden, who will be 63 on July 2, is expected to remain in government service in some capacity until he reaches the retirement age of 65. Possibilities include service with AGARD and the National Academy of Sciences, as well as staying with NASA in another capacity. He has been home secretary of the academy since 1955.

• **Delays detailed**—The Glennan stretchout affects plans for first instrumented flight to Venus, the first launching of the Orbiting Astronomical Observatory, flight test of the *Rover* nuclear-thermal rocket, flight qualification of the 1½-million-lb.-thrust F-1 engine and flights of the *Apollo* three-man spacecraft.

Glennan said the 10-year plan, first presented last year, "has recently been revised in the light of our experience during the past year." A NASA spokesman said the revisions were made within NASA and not at the White House or the Budget Bureau. Asked whether the reason was funding or technical factors, the spokesman said he assumed both came into play.

A source close to the incoming administration predicted the whole program will be reexamined after Jan. 20. "We will start with no preconceived notions," he said.

The first instrumented flight to Venus was delayed from 1962 to 1964. Last Oct. 26, R. J. Parks, director of the planetary program at NASA's Jet Propulsion Laboratory, announced plans for a Venus fly-by as the first mission of Project *Mariner* in 1962 (M/R, Jan. 2, p. 14). Under the new program a "planetary spacecraft" is to be launched in 1962, but no attempt will be made to direct it to the vicinity of Venus. Reconnaissance of both Venus and Mars was set for 1964.

Glennan delayed the first launching of the Orbiting Astronomical Observatory from 1963 to 1964. The *OAO* has been under development for three months, under contracts with Grumman and Westinghouse. NASA officials would not say whether funding or problems discovered since Oct. 10 caused the delay.

• **Studies unnecessary?**—The flight test of the nuclear rocket was moved back from 1965 to the 1966-67 time period. The change surprised observers because Harold B. Finger, chief of the joint NASA-Atomic Energy Commission Nuclear Propulsion Office, said recently that the timing and nature of the flight test would depend on the outcome of contracted studies still in progress.

Glennan set the final qualification of the F-1 engine for 1965. This was an addition to the program, since preflight qualification in 1963 was all that had been previously approved. However, it was a stretchout in the sense that engine qualification can be accomplished in as short a time as six months if there is any urgent necessity. Apparently, Glennan scheduled a leisurely qualification because he did not expect any need for the engine before that time.

The exact amount of the stretchout of the *Apollo* program was somewhat obscure. Robert R. Gilruth, director of NASA's Space Task Group, told the Goddard Space Flight Center industry briefing last Aug. 30 that *Apollo* "active flight testing and mission flights" would take place in the 1965-70 period.

Under the new schedule, only a prototype capsule test is to take place in 1965 and the manned orbital space station and circumlunar flights were set for the 1968-70 period. Apparently, the new schedule cancels plans for a prototype *Apollo* capsule flight, which had been scheduled for the eighth *Saturn* flight, in 1963.

## NASA's New Long Range Plan

**1961**

Suborbital manned flight
Centaur launching
X-ray astronomy satellite
Orbiting Solar Observatory (OSO)
Ranger spacecraft launching
Orbital manned flight
Saturn booster launching

**1962**

Lunar landing, Ranger
Topside ionosphere satellite (Canadian)
Planetary spacecraft launching
Nimbus meteorological satellite

**1963**

Active communications satellite
Saturn 2-stage launching
Soft lunar landing
Saturn 3-stage launching

**1964**

Orbiting Astronomical Observatory (OAO)
Flight qualification of 200K hydrogen engine
Unmanned Mars or Venus flyby

**1965**

Flight qualification of 1500 K F-1 engine
Apollo prototype capsule test

**1966-7**

Saturn C-2 3-stage flight
Nuclear-thermal rocket flight test
Lunar landing with mobile instruments.

**1968-70**

Attempt at orbit of another planet
Apollo manned flights

*first photos*

# 'Private Ocea

## *Models tested at Lockheed's LUMF saved money, proved out feasibility of missile's launch method*

A PRIVATE OCEAN built to launch-test scale models of the Polaris missile has been credited with saving millions of dollars and man-hours.

Thousands of launching tests were conducted by Lockheed at its Underwater Missile Facility (LUMF) before the Polaris became operational. The tests proved feasibility of the launch method and provided vital data on the hydrodynamic performance of the missile shape under an infinite variety of launching conditions.

Encased in a cylindrical steel tank, LUMF can provide simulated conditions almost identical to those in actual submarine launchings. Waves can be produced accurately in scale up to near-

**LEFT:** *SMALL-SCALE Dummy Polaris missile is lowered into launching tube for under-water launching test. Missile enters through hatch in pressure hull surrounding test facility.*

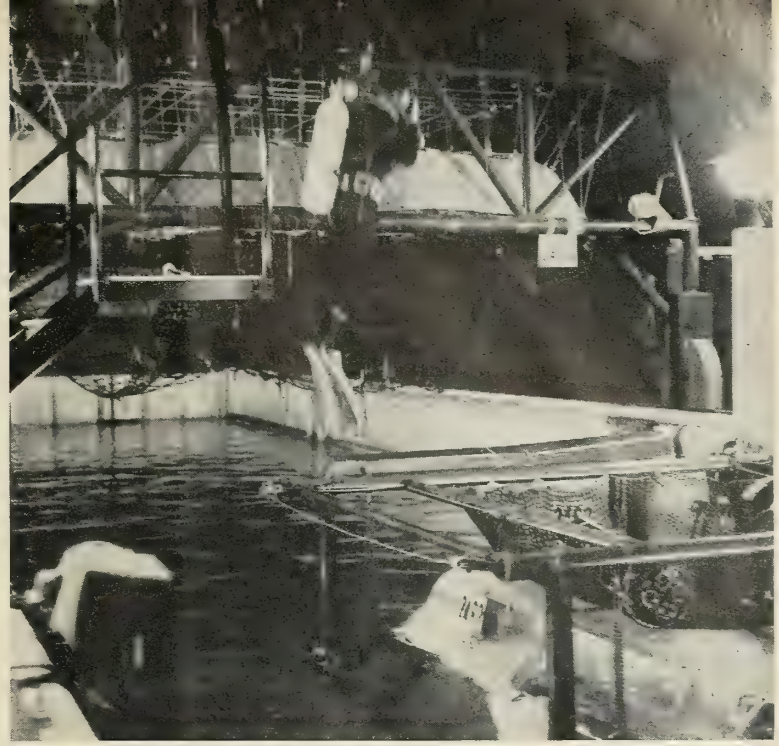


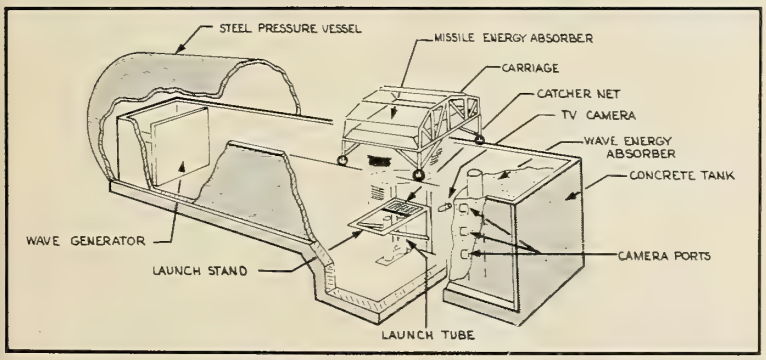
*LOCKHEED UNDERWATER missile facility is encased in a pressure hull so the 85-foot long tank can be reduced in atmo-*

# or Polaris

hurricane force. Internal pressure can be reduced in the tank to provide a realistic differential consistent with that encountered in full-scale operation. Pitch, roll, and forward motion can be simulated.

In test launches from the sub-scale version of the submarine's missile section, ultra-high-speed motion picture cameras record the underwater trajectory. Data from instrumentation in the missile models and in the tank is recorded on magnetic tape and oscillographic tracings in a shack near the tank. There, engineers also monitor the test by remote closed-circuit TV. ❖






**ABOVE:** *SUBMERSIBLE TEST STAND (just awash in foreground) contains scaled-down Polaris launching tubes in fairing designed to simulate section of Polaris submarine hull.*

**LEFT:** *STEEL PRESSURE VESSEL encloses entire assembly, wave generator, launcher, catching rig, camera ports, and beach at one end which dissipates wave return.*

**BELOW:** *MISSILE MODELS are launched by rig, (center) immersed for tests. Remotely operated TV camera (lower left) monitors tests. Frogman assigned to the project maintains underwater equipment.*



*spheric pressure to simulate differential between sea surface and submerged missile submarine.*



# Solar Flares Pose Weight Problem

***Grumman engineers urge use of ablative materials, propellants, equipment and structure as shielding to reduce burden***

NEW YORK—Shielding weighing 5000 lbs. may be required to protect one man from a solar flare equal to that of May, 1959.

Grumman engineers T. G. Barnes, E. M. Finkelman and A. L. Barazotti reported their calculations in a paper given at the Lunar Flight Symposium, sponsored by the American Astronautical Society as part of the annual meeting of the American Association for the Advancement of Science.

To reduce the dead weight of radiation shielding in spacecraft that travel beyond the Van Allen belts, the Grumman engineers proposed maximum use of ablative materials, propellants, equipment and structure as shielding. As one example, they suggested that a maximum-hazard compartment might be set up at the center of the craft, within a LOX tank.

Solar flares were broken down into two categories: the very large flares emitting protons in the very-high-energy range, of which there have been six in the last 18 years, and those discovered during the International Geophysical Year, which have particles of lower energy but much greater numbers of particles. The May, 1959, event was an example in the second category.

• **Rare events**—The IGY-type flares occur about once a month during solar maximum, which was in 1957-59. K. A. Anderson of the State University of Iowa has suggested that the frequency may fall to less than three a year at solar minimum, due in 1963-64, and that events such as May, 1959, may occur only about once a year during maximum activity periods of the solar 11-year cycle.

For a five-day, low-energy swing around the moon, they noted, the probability of encountering a major solar flare is less than 2% for a period when flares are once a year and about 16% for a period when flares come about once a month. However, with the use of a technique developed by Anderson for predicting flares two days in advance, the probabilities are reduced considerably. They said it is doubtful that the Anderson prediction method can be extended beyond four days.

Protection for manned spacecraft was calculated on the basis of facts known about solar flares of March 23, 1958, Aug. 22, 1958, and July 14, 1959, as well as the May 10, 1959, event.

**Important Solar Flares**

| Date of Observation | Data | Observer |
|---|---|---|
| March 23, 1958 | 0.11 protons/cm-sec-ster above 120 mev (balloon) | J. R. Winckler |
| Aug. 22, 1958 | 100-570 protons/cm$^2$-sec above 100 mev (satellite) | K. A. Anderson |
| May 10, 1959 | 1000 protons/cm$^2$-sec above 110 mev (balloon) | J. R. Winckler |
| July 14, 1959 | Inferred 17,600 protons/cm$^2$-sec at 40-500 mev in space from balloon measurement | J. R. Winckler, R. R. Brown |

Allowing for dose limits of 5 rem in the spacecraft design and 25 rem in case of emergency, they figured that shielding of 10 grams of carbon per sq. cm. would shield adequately against protons of the inner Van Allen belt and against flares as big as those of March and August, 1958. However, the May, 1959, flare would require 40 grams per sq. cm. of carbon. Tissue doses were calculated with the assumption of radiation biological effectiveness (RBE) of 2.0 for proton energies less than 40 mev and 1.0 for higher energies.

Using carbon shielding, they arrived at a weight of 5000 lbs. for an emergency shield for one man, a cylinder 2 ft. in diameter and 6 ft. long.

• **Geometry a factor**—The Grumman engineers reported that the choice of shield materials for minimum weight depends on geometry, as well as radiation types. For slab geometry, low atomic weight materials are best for reducing the flux of primary protons, the major element of danger to man in solar flares and the radiation belts. However, the density effect tends to favor heavier materials when curved shielding is required, and as the radius of curvature is decreased.

They chose carbon as a reasonable compromise for their calculations, because it is a good choice over a fairly wide range of radii. However, carbon has a high cross-section for producing secondary neutrons. Other possibilities discussed were lead, aluminum, beryllium and liquid hydrogen.

Although solar flares are the primary danger, calculations were also made for the radiation belts and galactic cosmic rays.

Cosmic rays—consisting of about 85% protons, 13% alpha particles and less than 2% particles of higher atomic number, all stripped of their electrons—have an energy spectrum extending up to $10^{12}$ mev. Fortunately, however, their flux is extremely small. The total integrated flux for a year may be less than 10 roentgens, they said. This is double the newly lowered maximum radiation allowance for industrial workers, set by the Atomic Energy Commission.

• **Safer than solar flares**—Although complete energy spectra for the Van Allen belts are not yet available, the Grumman engineers concluded that the danger is less than from major solar flares.

For example, they calculated that inner belt protons in the 20-60 mev energy range would provide incident flux of 5 x $10^6$ protons per sq. cm., about 1/10,000 that required to damage a silicon solar cell, in an escape trajectory from a 100-mile orbit out through the polar regions. Outer belt electron intensity would be about the same proportion of that required for damage.

However, protons of 35 to 140 mev in the May, 1959, flare would have been in excess of the flux needed to do damage.

They suggested that addition of cover glass over solar cells might protect them from electrons, but not solar protons. The most promising approach, they added, is the development of radiation-resistant cells. ⁂




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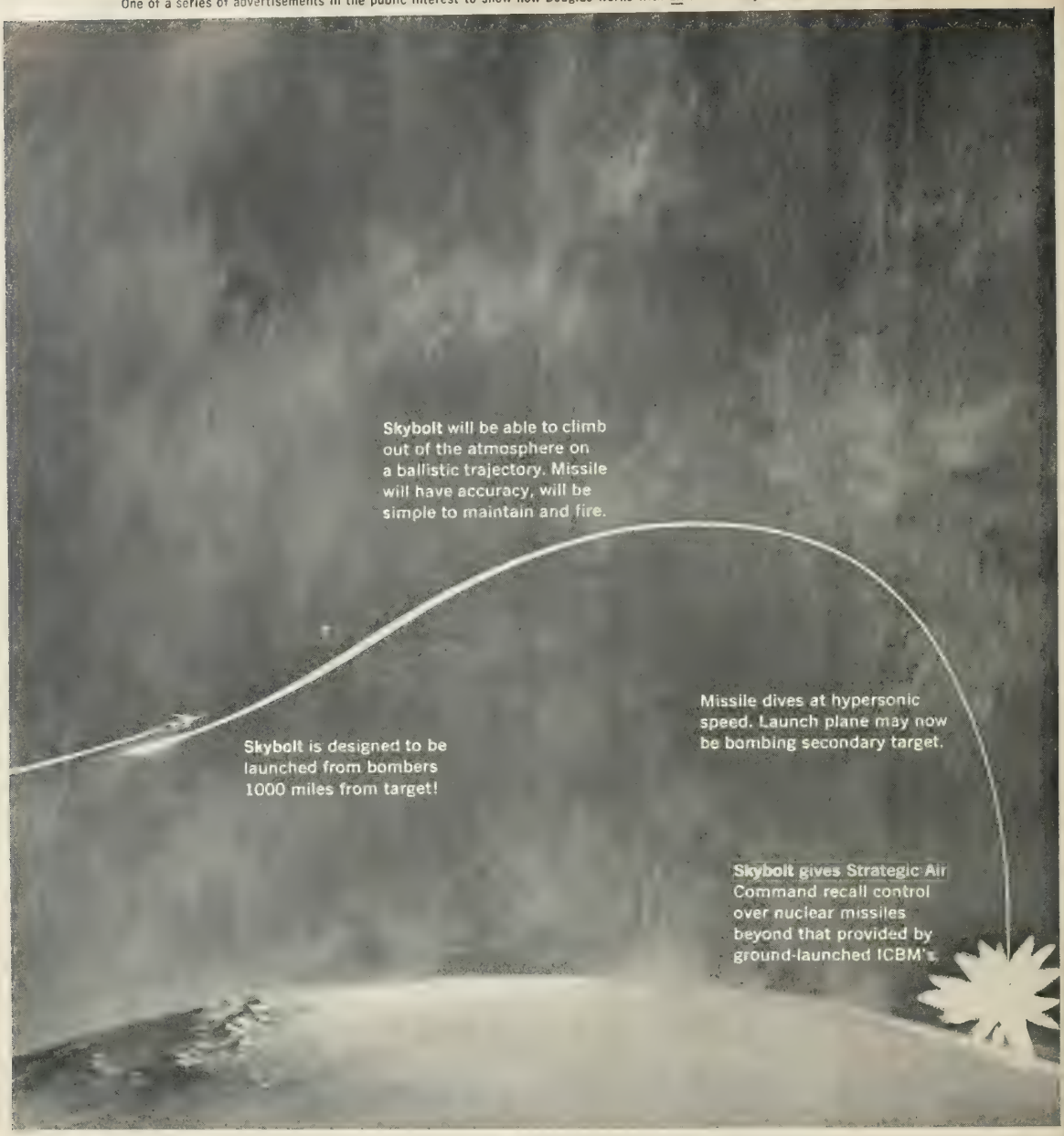
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# Technical Countdown

## ELECTRONICS

### Creeping Sophistication and Red Ink

Informed electronics industry spokesmen have told TECHNICAL COUNTDOWN that slowdown on numerous NASA development contracts occurs because of the space agency's penchant for "creeping sophistication." Progress becomes snarled by continual demands from NASA representatives for system modification—usually without benefit of increased funds or extended delivery dates. The end product, they say, is still behind the state of the art and delivered too late, and the contractor earns only another loss statement for his efforts.

### Lunar Temperature Studies Extended

Scientists at Hughes are preparing to employ long-wavelength infrared techniques at various high-altitude locations to study lunar atmospheric characteristics and spatial background. Their current studies of lunar-surface temperature change, using reflecting optics and radiometric measuring systems, are similar to the recently reported Boeing lunar research (M/R Jan. 2, p. 39).

### FCC Investigates Space Communication Needs

The Federal Communication Commission has broadened its investigation of long-range needs for radio spectrum allocations for space communications. It will also take a look at the possibility of reserving sparsely settled sites to provide earth terminals for space systems. Because of the urgency of the matter, FCC may, in addition, include some research on space communications in its inquiry.

### NBS to Listen to Earth's Pulse

The Bureau of Standards will shortly begin a study of micropulsations—faint low-frequency electromagnetic waves —which exist around the world. Eight six-foot loops, each containing 130 miles of hair-like copper wire, will serve as antennas to pick up these oscillations below 20 cps. The signals are much stronger in the auroral zones and it is thought that they are associated with the influx of primary electrons into the ionosphere due to solar storms.

### Time-Signal Broadcasts Changed

Standard time signals broadcast by WWV and WWVH have been retarded by 15 milliseconds to bring them into closer agreement with other standardized frequency broadcasting staitons throughout the world. In addition, the special binary coded timing signals—tried experimentally in 1960—have been put on the air by WWV on a permanent basis. The timing code will provide a basic standard for simultaneous global scientific observations such as the recording of data telemetered from satellites.

### AF Initiates New Battery Study

Satellite battery life and performance data never before available is expected to come out of an Air Force (WADD) life-testing program conducted by Cook Electric. Nickel cadmium batteries will be run until failure under simulated space temperature and charge-discharge cycle conditions. The tests—to continue for more than a year—will establish expected lifetimes and failure rates for the batteries and show why they fail.

### EPRA Working on Electronic Component Forecast

The first five-year forecast for military requirements of 13 different categories of electronic components is scheduled for publication next July. The Electronics Production Resources Agency forecast will cover various types of batteries, capacitors, transformers and reactors, instruments, relays, quartz crystals and filters, vacuum tubes, semiconductor devices, connectors and servo devices.

## GROUND SUPPORT EQUIPMENT

### JPL 250-Ft. Dish Under Study

Four study contracts have been awarded by NASA's Jet Propulsion Lab for a new over-size space-tracking antenna. The four competing companies designing the 250-foot dish are Hughes Aircraft, Blaw-Knox, Westinghouse Electric, and North American Aviation.

### Reactor Instrumentation Simplified

General Electric's newly developed "neutron telescope" is an important step toward simplifying nuclear reactor instrumentation. Basically a fast neutron counter housed in a special tube, it measures small changes in steam output of selected fuel channels. It functions from a distance of 20 feet or more through six feet of water and more than two inches of steel.

## ADVANCED MATERIALS

### Rocket Use of Steel, Aluminum to Decline

A survey of developments in the areas of case, nozzle and insulation materials by Grand Central Rocket disclosed that steel and aluminum face a dwindling market while titanium, reinforced plastics, graphite, ceramics and cermets have bright prospects in the coming decade. Beryllium and the exotic metals will be used—but in a restricted sense, because of fabrication difficulties and high cost.

### Russians Pick Up Hopkins Process

Electroslag melting of steels for tubing and bearings is under way at the Dneprospetsstal Metallurgical Plant. The Russians credit this process, which is also used in the U.S. by Firth-Sterling, with producing more weldable alloys.

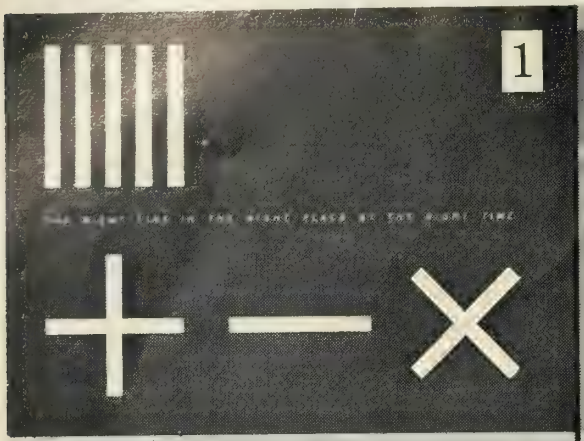
### Titanium Bounces Back

Mill product shipments of titanium in 1960 hit 10 million lbs.—a 50% increase over 1959. The increase is believed to be partly due to the price competition the wonder metal is giving other, more established, engineering metals. A growing missile use of titanium also helps; this is expected to continue fairly constantly through 1961.

### Machining-Information Center Established

The Metcut Research Machining Data Center, established by Metcut Research Associates, Inc., is starting to gather, correlate and develop machining information on metals, alloys and non-metallic materials. The Center expects to become a national source of such data and to provide facilities for experimental development and application of machining and machinability information.

# Which of These 4 Major Improvements Is Most Important To Your Business?













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1 A NEW CONCEPT OF PLACING the Right Line—in the Right Place—at the Right Time. The Avnet System supplies not only the components themselves but a wealth of application information, saving the user hours of costly research time.

2 A NEW CONCEPT OF SUPPLY—an available supply that is overwhelming in its size. Avnet's supply of electronic components is vast—in breadth and in depth. It is also carefully anticipated to meet your demands of tomorrow, next month, next season.

3 A NEW CONCEPT OF TIME. Avnet ships your orders about ⅓ faster than any other major source of supply, hence ⅓ of the hours can be cut from your waiting time. Although the 8 hour clock is symbolic, it is symbolic of a fact.

4 A NEW CONCEPT OF SCHEDULING. Once your order is given to Avnet, it knows no "weak-ends." Within a given period, Avnet ships more orders than any other source for electronic components, giving your specific order quicker delivery, faster use.




5 THE CONCEPT OF NEW CHALLENGE. Avnet doesn't know what the next decade will bring. But Avnet is very ready, willing and able to meet the challenge with *more* improvement in service, *more* newness, *more* changes for the better. For this is the very basis of The Avnet System.

**AVNET** (A)

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Circle No. 4 on Subscriber Service Card.

# SLAG Makes Polaris Firings 'Fail-Safe'

***Kearfott-developed system could be installed on surface vessels carrying operational birds; dual unit has perfect record***

**by Ben Strunk**
*Project Engineer*
*Kearfott Div., General Precision, Inc.*

THE SAFETY OF shipboard personnel during surface test launchings of the *Polaris* IRBM is preserved by a unique fail-safe system called SLAG (Safe Launch Angle Gate) whose primary function is to prevent launching if the ship's list angle is unsafe.

Now installed aboard the Navy's USS Observation Island, it may eventually find broad operational use.

A revival of interest in this system has been sparked by the possibility that *Polaris* missiles will be installed operationally in surface vessels, as well as by the fact that the newer and longer-range *Polaris A-2* and *A-3* also will be test-fired from the Observation Island.



*TEST LAUNCH of dummy* Polaris *from Observation Island shows how ballast and stabilizer fins impose list. SLAG would prevent launch when list is dangerous.*

Developed by Kearfott Division of General Precision, Inc., for Lockheed, SLAG was conceived, built, and delivered to the Navy in less than six weeks.

Installed late in 1958, the system has been used continually ever since without failure.

• **Ignition failure serious**—When the *Polaris* is launched, compressed air is used to blow it into the air. Before the apex is reached, the first stage ignites. This is done to avoid blast effects and heat damage to the launching vessel.

But if the first stage fails to ignite, the missile could fall back onto the ship.

This problem is of course particularly severe when surface ships are involved. Although ballast and stabilizer fins are used to impose a list to starboard while the Observation Island is under way, normal ship roll could still present a problem.

SLAG was developed as the immediate solution to this problem.

The system is used in three ways:

1) to indicate visually (and accurately) angle of list,

2) to exhibit relative amplitude of roll, and

3) to prevent missile launching if the list angle is not safe.

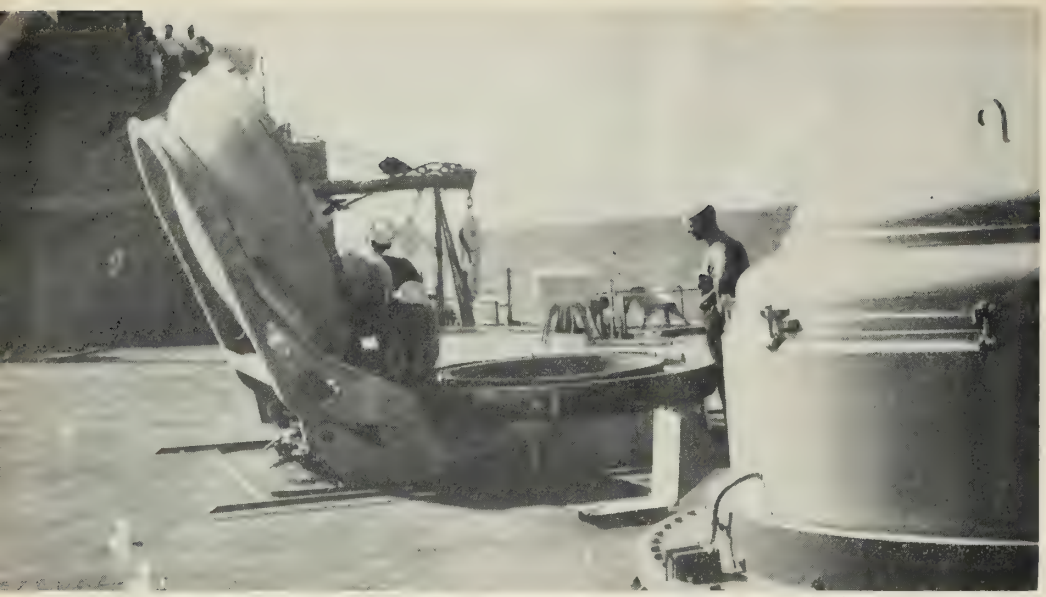
• **Fail-safe feature assured**—SLAG is a self-contained dual unit. The Navy required that two complete systems be housed in one module, with "Permission-to-launch" switches arranged in series. Hence, if either system fails the other switch will remain closed and the missile cannot be launched.

Once it is determined which system was faulty, it is only necessary to flip a switch to place the good system in operation alone.

Each of the two systems contains the following equipment:

1) A vertical gyro.

2) A switching network which con-



*COMPRESSED-AIR LAUNCH CHAMBERS installed in the USS Observation Island: in the foreground, a fixed vertical tube; in the background, a tiltable tube assembly.*

tains on-off switches, indicator lights, time delay relays and circuit breakers.

3) A DC power supply.

4) A servomechanism-driven indicator assembly with switches for safety gating.

5) Remote indicators.

A clinometer is used to test the actual tilt angle of the vertical gyros. Results are compared with the system readout to check system accuracy.

Because of the duality of the unit, self-checking was not a design requirement.

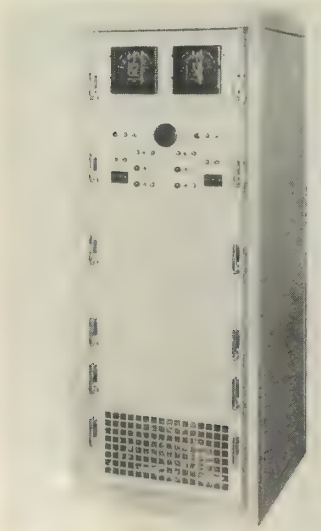
Three remote indicators are employed aboard the Observation Island: one near the SLAG console, one on the bridge, and one in the vessel's telemetering center. Indicators have a built-in memory to show maximum and minimum roll.

• **System operation**—The vertical gyro, which acts as a reference, transmits roll signals to the servomechanism assembly. In response to this signal, the servomechanism drives the indicators and switches, and a torque transmitter.

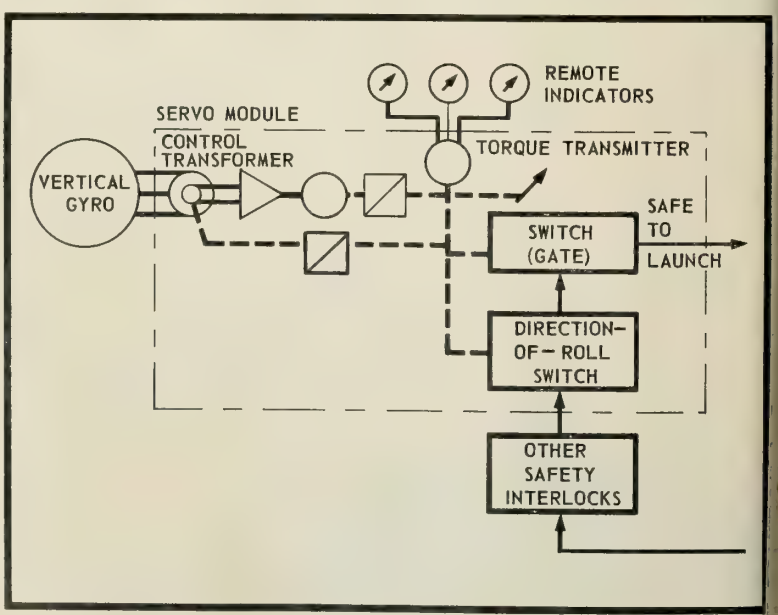
The torque transmitter in turn drives the three remote indicators to give a visual indication of the ship's list angle and the amplitude of its roll.

The servo closes a switch (gate) when a safe launch angle has been reached, and opens the gate when the ship is at, or rolling *toward*, an unsafe list angle.

The entire system indicates to an accuracy of ± 20 arc-minutes over a range of 15° port or starboard roll. The remote instruments indicate to an accuracy of ± 30 minutes. ⁂



*SLAG actually is a dual unit containing two complete systems connected in series as a fail-safe feature.*




*SCHEMATIC DIAGRAM of one of the two systems comprising SLAG.*

# IBM's New Cryogenic Memory Planes

***Automatic control techniques produce economically feasible volume of tiny components formed by thin-film deposits***

CRYOGENIC THIN-FILM memory planes are now being fabricated successfully by International Business Machines Corp. as a production item.

For the first time, IBM scientists reported, fully automatic control techniques have been introduced to provide an economically feasible yield of the postage-stamp size components.

The memory planes employ 19 thin-film layers to produce a 135-cryotron assembly. Fabrication techniques were developed by IBM's Federal Systems Division laboratory in Kingston, N.Y.

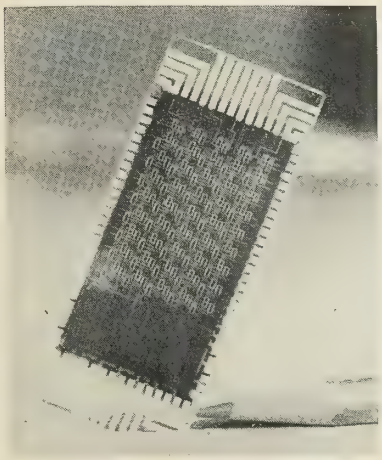
Cryogenics (using temperatures of the order of –450°F) have been employed for some time in devices used to perform logic and to store information in a computer memory.

In a cryogenic computer, cryotrons are used to perform addition, subtraction, multiplication, and division as well as logic, switching, and amplification.

In the new IBM memory plane, three cryotrons form a memory cell which combines storage with an elementary logic operation. Given this combination of functions, the company said, sophisticated operations not practical before may be realized. For example, IBM scientists expect that this concept may be used in an "associative memory," which simultaneously searches all memory compartments and thereby speeds access to any stored information.

• **Key to success**—The heart of this advance in cryogenic-device development is the technique permitting accurate duplication in the normal production of devices. In manufacturing the memory planes, microscopically thin layers of metals and insulating materials are automatically deposited on a glass substrate.

The equipment used for deposition allows each functional layer to be deposited sequentially through 17 microscopically adjusted masks, or perforated metal sheets. Masks are changed automatically and held in a large metal cylinder operating under high vacuum. Once the masks have been aligned properly, duplicate superconducting memory planes are produced automatically with similar electrical and mechanical characteristics.



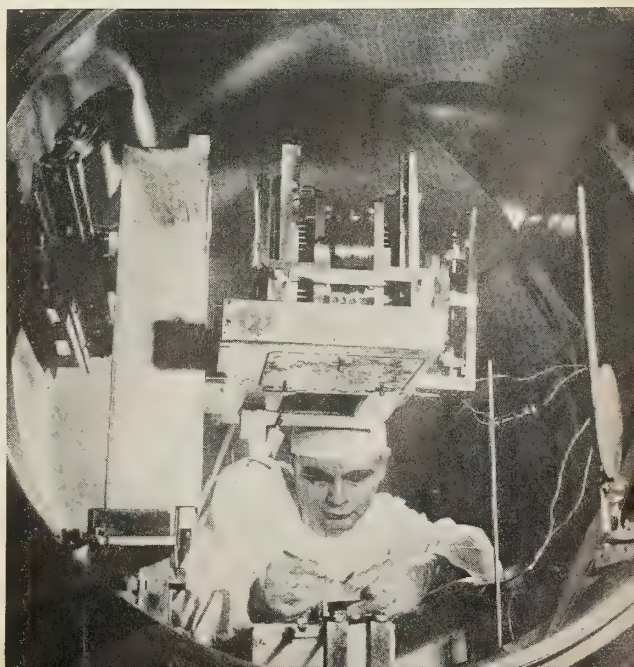
*STAMP-SIZE, 135-cryotron, thin-film memory plane made automatically by IBM.*

Forty separate pieces or "bits" of information are stored in 120 cryotrons in the memory plane. Of the remaining 15 cryotrons, 10 permit access to the stored data; the other five are "in-line" cryotrons which switch information bits from one memory plane to another.

These newer "in-line" cryotrons, reportedly, operate faster than conventional cryotrons in communicating between the memory planes. They also permit faster communication between the memory planes and the arithmetic portion of the computer.

Basic building block of the cryogenic memory plane consists of three crossed-film cryotrons in combination with a persistent current loop to make up a storage cell. The word-oriented (two-dimensional) memory plane consists of eight-word registers with five bits/word, providing a total of 40 memory cells.

Research is being continued to refine the thin-film fabrication techniques for producing cryogenic devices at even greater speeds, the company said. ❖



*AUTOMATIC deposition equipment developed by IBM's Federal Systems Division for sequentially depositing 17 crossed-film layers on a glass substrate.*

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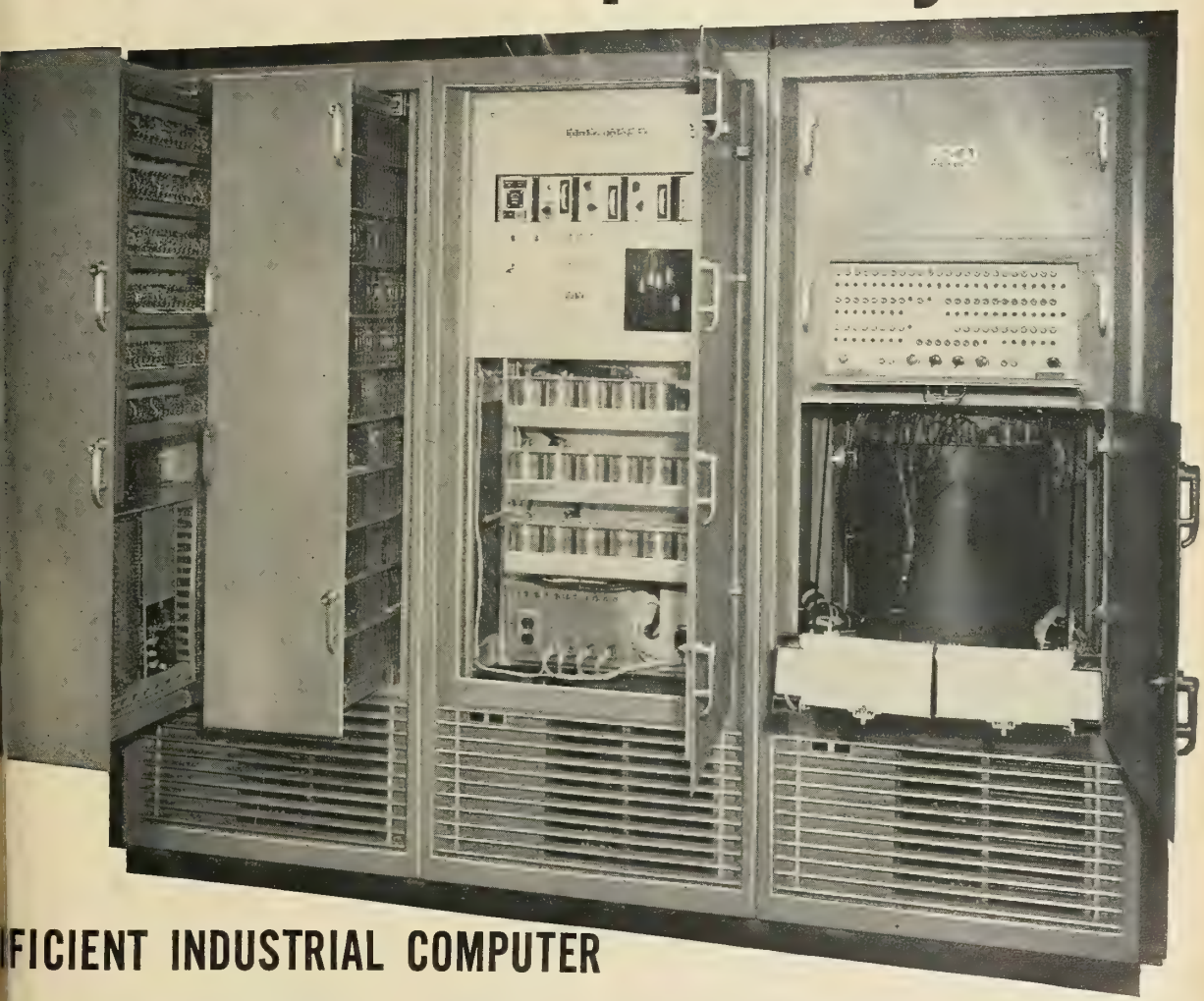
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Circle No. 5 on Subscriber Service Card.

# Seismology Takes To Undersea Warfare

***Dresser finds oil hunting techniques apply to identifying, targeting enemy submarines; beacon built for ocean bottom Polaris navigation***

**by Hal Gettings**

HOUSTON—Detection of enemy submarines—one of the knottiest problems plaguing our undersea defenses—is being improved by techniques developed for locating underground oil deposits.

Although any rational connection between the two might appear farfetched, there is actually much in common between seismic oil exploration and certain aspects of antisubmarine warfare. Many of the problems are the same, or similar. And the solution to these problems in one area often applies directly to the other. In short, if you can find oil, you can find submarines.

In searching for oil, explosives are detonated under the earth's surface and recordings made of the energy waves reflected by the explosion. Analysis of these recordings provides the seismic engineer with data as to location and composition of particular characteristics of the earth's substrata. From this, geophysicists deduce the chances of finding oil in certain locations.

Some of the same principles apply to the detection of submarines beneath the surface of the sea.

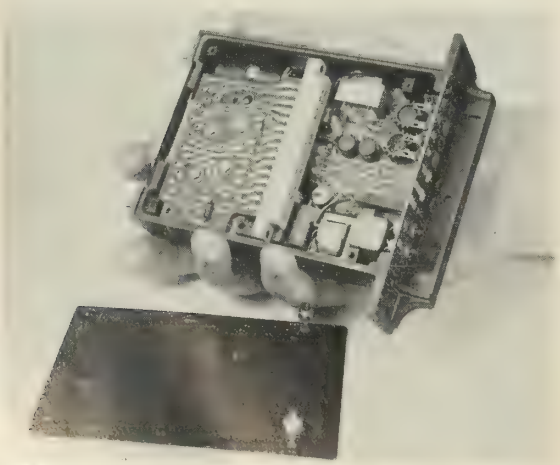
A good example of the application of these techniques to the development of systems to find and identify submarines is the work being done by Dresser Electronics' SIE Division. Drawing on an extensive 15-year background in seismic exploration, SIE has turned a large part of its effort toward producing ASW equipment. They began their "plowshares-into-swords" approach several years ago and have since become deeply involved in sonar research and development. Similarly, their oil experience has been profitably applied to instrumentation for missile telemetry and space applications.

• **Underwater beacon for Polaris subs**—As one example, know-how developed from both seismic experience and well-logging instrumentation—with its extreme environmental temperature and pressure requirements—was used in the recent development of an underwater navigational beacon.

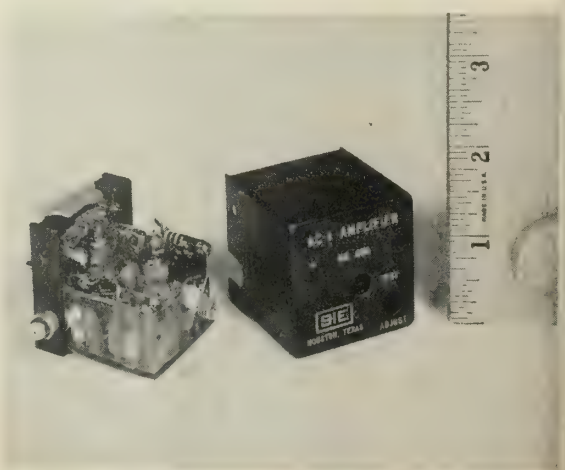
This beacon, part of the *Polaris* program, required sound levels and efficiencies in a package size and weight thought to be absolutely incompatible. The Dresser approach was selected by the contracting agency as "very interesting, if possible." The end result was a navigational beacon to specifications including operation at ocean bottoms down to 20,000 feet.

• **ASW surveillance system**—Dresser is developing an underwater target identification and display system for the Navy. Details are classified, but the design is based on seismic data processing and digital computer techniques. The system is directly adaptable to solution of ASW surveillance display and target recognition problems.

The display system is preceded by a digital multibeam formation system so that surveillance is effective in all directions at the same time. The mass of data collected is computer-processed, since no sonar operator could assimilate the data and make a deci-



*[illegible] AUTHORIZED signal-conditioning module built by [illegible] for geometry applications for Subroc, Polaris missiles.*




*COMPLETE MULTISTAGE a-c accelerometer amplifier is packaged in 1 1/2-in. cube. Device grew from geophysical work.*

sion in the required time nor separate targets of interest from false targets.

Processed data is displayed to the operator at high signal-to-noise ratio and with a given "level of confidence" cranked into the system to suit the surveillance requirements of the situation. Thus the operator can exercise his recognition and decision function with clear and uncluttered data.

Another family of devices, perfected for portable oil exploration use, is Dresser Electronics' solid-state miniaturized power supplies. These already-ruggedized units required only a minimum of redesign for immediate application in aircraft, missiles, and submarines. Used in *Polaris, Pershing* and other similar projects, such power supplies are now being considered by major airlines for civilian use.

• **Back to plowshares**—The experience cycle is now turning full circle. Dresser finds that know-how gained on military contracts leads directly back into new developments for the industrial market.

From combined military and seismic engineering groups has emerged a new solid-state geophysical amplifier that combines transistors with other compatible solid-state components to take advantage of entirely new circuits that yield significant improvements in amplifier performance.

• **Building national radiation monitoring system**—Product capabilities have now been extended into complete systems concepts. A current example is an automatic radiation monitoring system being developed for the Office of Civil and Defense Mobilization (Project ARMS).

ARMS—a "system within a system"—in nationwide use will allow civilian defense personnel to answer two vital questions following atomic attack: is any given populated area safe or unsafe? If it is unsafe, where can the people be sent?

To inform supervisory defense personnel of relative radiation intensity in a populated area, radiation monitors are located within the area at strategic points. These are connected either by wire or low-powered radio to a central interrogation and monitoring unit. At this central point, the existing radiation level is displayed automatically on a continuously up-to-date map of the area.

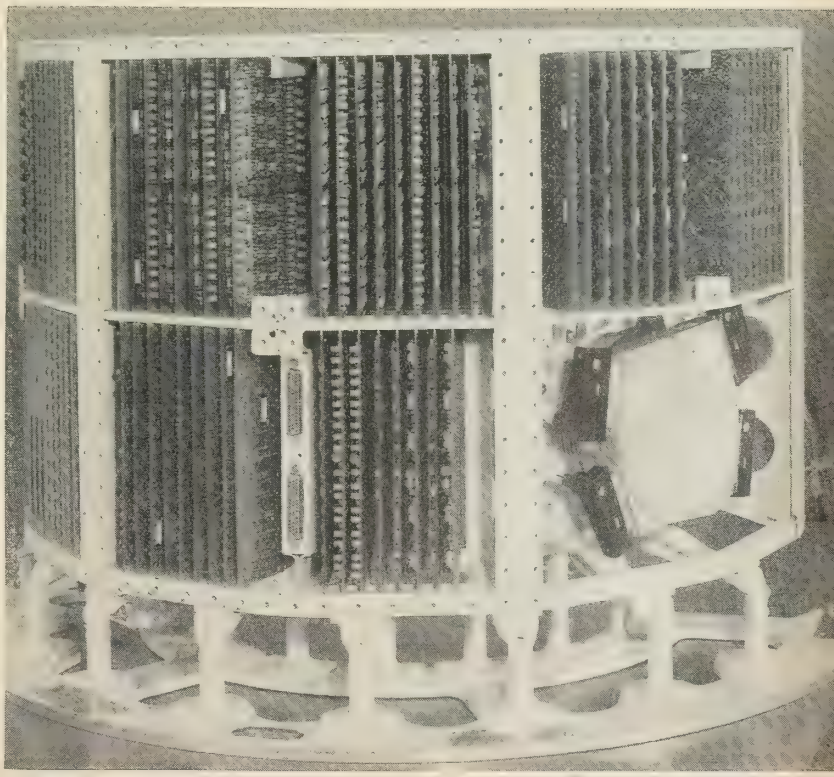
A network of similar radiation monitors will also be established on a nationwide scale, with approximately 64 monitors in each "block" of a grid pattern. Reports from these monitors will be fed to data reduction centers and the data displayed on a chart similar to that used for the city units. Field testing of the prototype ARMS units is scheduled to begin soon. ⁂

***First Photos . . .***

# Autonetics Unveils Minuteman Computer

IN ITS MAIDEN flight test from a silo at Cape Canaveral, a full-scale *Minuteman* will carry aloft in its all-inertial guidance package the cylindrical digital computer shown here. These first photos show it being vibration tested (at right) on a shaker at Autonetics, North American Aviation, which developed the *Minuteman* guidance system. The unusual shape of the solid state computer (below) permits it to fit compactly in the guidance compartment. The computer, in addition to in-flight functions, also performs ground checkout duties prior to missile firing. First test of *Minuteman*—with all three stages firing and with operational prototype guidance—is now expected late this month or early in February. GSE problems have delayed the shot a month.





# High Temperatures Foiled By Foam

***"Self Sacrificing" polyurethane coating applied by spraying Two-part Material Bonds tenaciously to most surfaces***

DEVELOPMENT OF D-100 foam has given Dynatherm Chemical Corp. a double-barreled approach to the high-temperature coating problem. The foam, developed just a few months after D-65, an intumescing coating, has properties somewhat different than the previously marketed product. (M/R, March 28, p. 27)

A two-part mix, D-100 has been extensively tested under flame temperatures of 6000°F, losing 20% weight and 8% volume over a one-minute period. Tests were conducted on a 1-in. sample, with the flame 6 in. away.

Elbert Davis, Dynatherm's president, described the material as a self-sacrificing foam which does not melt or fracture under high heat conditions. He said production of the foam ingredients can be made in any quantity, and they are now available for commercial use.



*OXY-ACETYLENE FLAME reaching temperatures of 6000°F is applied to foam in lab test of properties. The 1-minute run resulted in 20% weight and 8% volume losses.*

Features of the polyurethane coating include rapid application and curing time, rigidity and ability to be deposited in very thick heat-resistant layers. D-100 also has insulating qualities that its predecessor does not have.

In recent tests Davis said, a nose cone configuration utilizing both D-65 and D-100 was subjected to a plasma jet with favorable results. The cone consisted of 60 mils of D-65 on the outside surface of 1/8 in. of graphite, backed up by 1/16 in. of D-100. The D-65 withstood 10,500°F for 10 seconds with less than 200°F temperature rise occurring on the inside surface of the cone by the end of the test.

The nearest competitive system under the same conditions allowed a 1000°F temperature rise inside the cone within three seconds. The particular instrumentation scheduled for use in the operational configuration of the cone could not tolerate the fumes generated by the D-100, however, and it was removed from the system. This is not a universally-applicable disadvantage, Davis said.

Slightly less expensive than D-65, the D-100 coating will be applied by a special metering and spraying machine developed for use with the material. The nature of the chemical action in D-100 requires that it be applied to the surface within a few seconds after mixing. This prevents mixing of large batches before application, and the special machinery will meter, mix and spray the coating automatically and with proper timing.

Now under evaluation for military service, D-100 has already been written into some specifications for heat-resistant equipment. The material bonds very well to most surfaces. A critical relay in *Minuteman* is currently using a shell of D-100 for heat protection as an evaluation test for production use.

• **Visual control**—Coloring of the ingredients provides a quality control device. With one ingredient black and the other white, a final shade of gray is attained which indicates if the proper mix ratio has been achieved. Any off-color shades are easily spotted as deficiencies in the mix ratio or in the foam's homogeneity. Total curing time for D-100 is about 30 minutes.

In its continuing program on high-temperature coatings, Dynatherm expects to include powdered ceramics and metals such as boron or titanium in the coatings, in order to bridge the gap between organic materials and inorganic coatings. The company also hopes to make a flexible version of the D-100 coating, along with versions featuring higher and lower densities than the 13 lbs./cu.ft. now offered. Other programs now in the works include better self-sacrificing materials which will erode at a controllable rate.

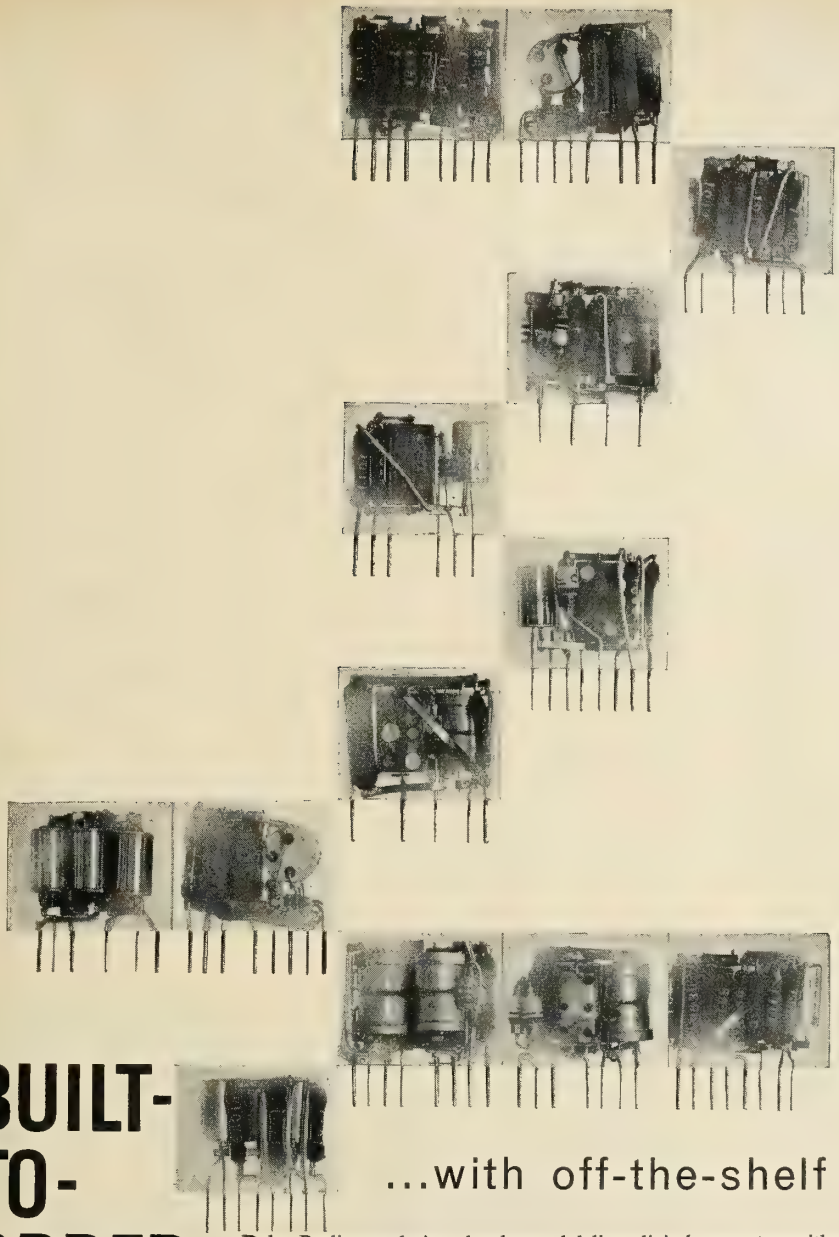
"I think this is a trend in such areas," Davis said, "because we are now reaching the limits of high-temperature materials as we've known them, and slower and slower progress is being made. We're taking another approach to the problem and we think it will pay off, where the application involved can afford the little space needed for a foam material." ⁂

## Man-made Diamonds Cross One Carat Mark at G. E.

LARGE DIAMONDS, in excess of a carat, are being made by researchers at General Electric Laboratories, Schenectady, N.Y. The gems are dark in color and are not yet of sufficient mechanical strength for industrial applications.

The large diamond work is still in the early development stage. Dr. Guy Suits, director of research, says it is impossible to predict when the stones will reach commercial applicability.

The Laboratory has already succeeded in manufacturing 0.1 carat diamonds with excellent industrial qualities but these are not yet available on a commercial scale. The first man-made diamonds produced by GE in 1955 were only thousandths of a carat in size.



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# Huge Press to Make Record Forgings

THE WORLD'S LARGEST multiple-ram forging press designed specifically for working steel, refractory metals and high-density alloys, went into operation recently at Cameron Iron Works, Houston, Tex.

The 20,000-ton closed-die press was designed by Cameron engineers and built in six months with the cooperation of Brown and Root, Inc., Bethlehem Steel Co. and Wyatt Industries, Inc.

With 15 feet of daylight, the press will turn out larger and more complex forgings than ever before possible. In addition, Cameron engineers expect a higher degree of controlled and uniform physical properties.

The frame is 50 ft. from bottom to top and 31 ft. in width. The bottom platen is 12 ft. square and the total stroke is 90 in. When the side rams have been installed they will exert 5000 tons each—with intensification, 7500 tons each. The piercing ram inside the main ram has a down acting range of 4200 tons. The four pull-back rams have a gross of 940 tons. The net stripping force is 400 tons with the bottom knock-out punch rated at 650 tons.

• **Vertical Extrusions**—The operator can drop the main piercing ram assembly out of the press, leaving a 56 in. hole in the main bolsters, in the moving platen, and in the top platen. Thus extrusions up to 30 ft. in length and 56 in. diameter can be produced. The only limitation is in the 30,000-lb. maximum billet weight.

No other press can approximate this extrusion ability and Cameron is eyeing the missile case area with renewed interest.

The throttling, or flow, control on the press is such that the machine can be operated anywhere within a range of 0 to 400 feet per minute.

Cameron perfected the split-die forging technique which drastically works the metal into shape in one heat and with a single, multiple forming, operation. On their 11,000-ton press, the main ram closes the die on the billet, two side rams pierce or forge in the horizontal plane and a vertical piercing needle is used to fill the die cavities.

This internal working of the metal breaks up segregated material inherent in the billet center and results in forgings that consistently meet high ultrasonic standards. The closed method avoids the flash line magnetic indications and the localizing effect of the flash grain on transverse, fatigue and stress rupture properties.

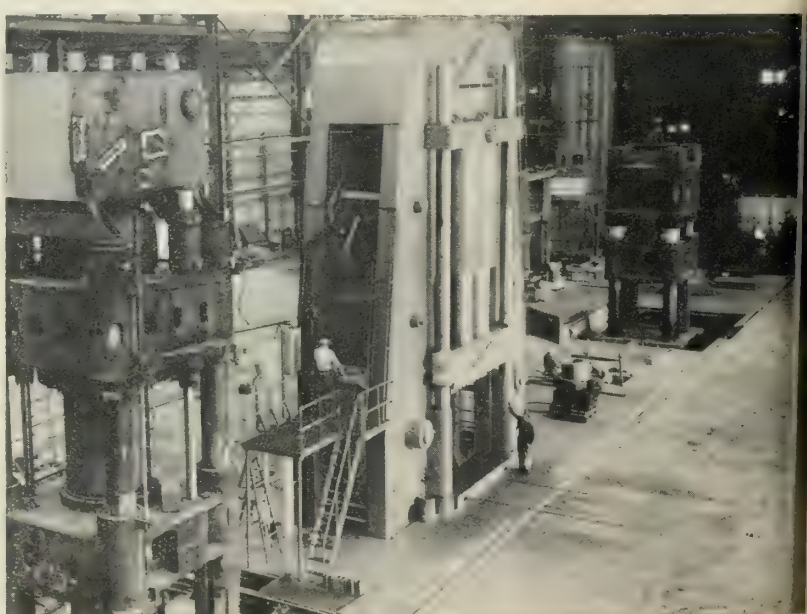
The new press extends this technique to larger pieces. It is the fifth largest closed-die press in the world, the other four are Air Force-owned and shared equally between Alcoa and Wyman-Gordon (M/R, Feb. 1, 1960, p. 18)

The 20,000-ton press weighs in at 3,158,000 lbs. excluding foundation. This is slightly more than the weight of the firm's 11,000 ton press, which gives some indication of the engineering innovations included in its design.

Cameron engineers will be using the press for nuclear reactor, jet engine and missile component applications. Molybdenum, tungsten, tantalum, moly tungsten, tantalum tungsten, columbium, and the more exotic alloys can be handled, especially as extrusions. ⌗



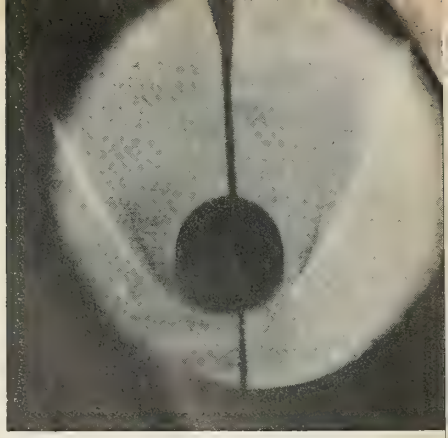

*REVEAL a 6000 lb. hollow ... of A286 stainless steel.*



*CAMERON'S 20,000 TON PRESS stands amid auxiliary presses. The accumulator system in the background consist of four Babcock & Wilcox units.*

# Supersonic Burning Probed; May Bring New Type Missile

## *NBS laboratory observes new phenomena—laminar combustion*



*SCHLIEREN PHOTOGRAPH CAPTURES what is believed to be first observation of laminar combustion in a supersonic stream. Missile M = 5.53, P(Abs.) = ¼-atmos.*



*ANOTHER SCHLIEREN PHOTOGRAPH shows large-scale oscillations in the megacycle frequency range. These were generated by the combustion process at the front of the missile. Missile M = 4.90, P(Abs.) = ¼-atmos.*

NOVEL TYPES of propulsion units may evolve from supersonic combustion studies now under way at the National Bureau of Standards.

The Bureau is exploring techniques which would generate thrust by having the burning process take place at supersonic speeds either inside—or on the exterior of a missile.

The Bureau also claims that the new study technique will help in the design of flame holders for supersonic combustion.

The method calls for firing a missile at hypersonic speeds through a combustible gas. Then high-speed schlieren photography is used to get data about the shape and detachment distance of the shock wave, gas density and other effects.

This information is evaluated to get a picture of the combustion process in the vicinity of the missile.

The experimental method was devised by F. W. Ruegg of NBS' combustion controls group. It is said to be a very low-cost method which has the added advantage of allowing experimenters to control precisely variations such as pressure, temperature, fuel and missile speed. This can be done over a wide range of values and under realistic conditions.

• **A new phenomenon**—During the studies, laminar combustion in a supersonic stream was observed for what experimenters believed to be the first time.

NBS also reported observing an unusual occurrence—large-amplitude oscillations in the megacycle frequency range produced by the combustion process at the front of the missile.

Under the Ruegg technique, a shock wave is established ahead of a high-speed missile. Then the conditions needed to induce combustion are found, and the effects of the missile on the combustion process determined.

The stagnation temperatures attained by this procedure are said to be realistic. The results are not affected by the method of mixing air and fuel or by turbulence.

The experiment can easily be modified to determine the effects of the temperature and pressure of the combustible gas on the combustion in the shock wave.

The Bureau's experiments were performed at Mach numbers from 4.2 to 6.5 in a mixture of hydrogen (30% by volume) in air. Combustion was initiated by means of compression and heating within the shock wave on the missile.

It was found that characteristics of the combustion process depended strongly on the Mach number and on the state of the gas ahead of the wave.

• **Apparatus used**—The experimental apparatus comprised three essential parts. First, a gun and a range that contained the missile and the test gas. Second, an electronic time-delay-ratio generator that computed the time to fire a high-voltage flash lamp. And third, an optical system for schlieren photography.

In the experiments, 0.785-in.-diameter nylon spheres were used as the missiles. They were mounted in a 20-mm case containing a fast-burning gun powder. They were fired from a .60-caliber, 6-ft-long test barrel through a blast chamber and test section into a heavy metal target and trap.

• **Results**—When the missile was traveling at a speed near Mach 4, separate shock and laminar combustion waves were observed at the front of the sphere. At about Mach 5, combustion was intermittent.

At higher speeds, the wave shown at the front of the missile was considered to be a strong detonation wave which separated into a shock and a laminar combustion wave.

At pressures of ¼ and ½ atmosphere, combustion caused the stagnation temperature to rise in the detonation wave by an estimated 700° and 1000° C., respectively—above the temperature due to the missile's motion.

The frequency of the intermittent combustion at the front of the spherical missile was estimated at 0.8 megacycles. Although extremely high, this frequency is not unreasonable when one considers the ignition delay time observed in experiments where combustion is steady.

This NBS study technique is being supported by the Navy Bureau of Weapons and the Air Force Office of Scientific Research. ⌗

*Status problem . . .*

# Engineers Have 'Inferior' Feeling

***Survey finds engineering talent in industry worries about pay, professionalism in relation to higher-living doctors and lawyers***

**by William Beller**

ONLY ONE OUT OF SIX engineers is satisfied with his profession. In fact, at least one out of every seven engineers thinks that engineering for industry is not even a profession.

These are the findings of a survey on engineering professionalism in industry made for the Professional Engineers Conference Board for Industry in cooperation with the National Society of Professional Engineers.

The survey is based on 350 interviews held between April and August last year and made by Opinion Research Corp. of Princeton, N.J.

What stands out in the findings is the engineer's intense desire to do creative and challenging work. The majority interviewed put this as their chief interest and reward, even above salary considerations—and far above questions of job security and status.

Still, for 36% of the engineers, salary was the most important item.

In the overall view, more than half the engineers said that higher pay would certainly advance engineering as a profession. It was not unexpected that less than one-fifth of the industrial managers agreed.

• **Who was in the survey**—All the engineers interviewed were working in recognized engineering assignments—no subprofessionals or technicians—and held college or advanced degrees in engineering. They were all with large companies employing many engineers.

The industrial managers interviewed included directors of industrial relations, vice presidents for production or production managers, chief engineers or managing engineers, project engineers, coordinators and the like. The interviewers' objective was to talk with men who set policies for the engineers in the companies represented.

The companies involved were representative of six major industries: chemical, electrical instruments and manufacturing, electronics, missile manufacturing, petroleum and rubber.

Even though the chief products of these companies came from engineering, the engineers themselves seemed to be suffering from feelings of inferiority. Only three percent of them felt that they had a higher status in their companies than the doctors and lawyers employed there.

Among the reasons given were that doctors and lawyers made so much more money than the engineers that they necessarily must command greater respect. They also have more of such symbols of office as private secretaries, parking spaces and longer lunch hours.

Furthermore, the doctor and lawyer were said to be their own bosses. "Their activities are unsupervised, they are free to come and go as they want. On the other hand, the engineers must sign in and out."

Implicit in the survey statistics was that the word "doctor" was considered synonymous with "physician" and not with "Ph.D."

• **No agreement on professionalism**—Only the industrial managers were anywhere near agreement on the criteria for "engineering professionalism." They said it called for technical competence and skill, and high standards of learning and ability.

On the other side of the coin, only a quarter of the engineers saw a relationship between these standards and professionalism. Their criteria for professionalism ranged from having "something like" the American Medical Association or Bar Association, to generating ideas, being effectively used, having a high standard of ethics, and being registered.

Most of the engineers and managers felt that building professionalism was very important for the engineers' and company's welfare. They also agreed that it was management's responsibility to advance engineering professionalism at the company.

Here are some of the things they said management could do.

–See that salary progression fully reflects engineers' contributions.

–Encourage engineers to find out how their work fits into the entire project.

–Give engineers as varied and challenging work as possible.

–Give engineers adequate supporting personnel.

–Keep engineers informed on company objectives and policies.

Most of the engineers said that there were things they could do for themselves to build up their professionalism—and that they were doing them. Here there was sharp disagreement from the managers, who claimed that the engineers were doing very little to advance their cause.

This poor opinion on the part of the managers was of high concern to the interviewers. They said that either (1) the engineers have to re-evaluate much of what they do now, or (2) they need to communicate better with their managers regarding the things they are doing to build professionalism.

Here is what the engineers say they are doing:

–Learning business objectives of their projects.

–Belonging to professional societies.

–Developing communication skills.

–Keeping informed on business conditions affecting the company.

–Keeping informed about the functions of the company.

–Seeking further education.

• **No love for trade unions**—Industrial managers were almost 100% agreed that unions hurt engineering professionalism. The engineers were not so adamant, although most of them (64%) agreed with their managers.

Among the reasons given were that the professional man should be treated as an individual. He doesn't want to lose his identity and become "part of the mob," which he would have to be as part of a bargaining union.

In addition, it is asserted that unions are associated with nonprofessional groups; they lower standards of initiative, accomplishment and ability; and in some instances have been associated with corrupt influences.

The survey can be wrapped up in three conclusions:

First, engineers can advance their cause best by doing those things that make them better qualified engineers.

Second, managers can advance engineering professionalism by giving their engineers the best possible working environment and recognizing their engineers' achievements.

Third, both groups can do much by improving their intercommunication. ⌗




***Today's combat decisions depend on lightning-fast calculations.*** *The answer is rugged, high-speed computers in the* ***field.*** *Autonetics fills this need with compact, solid-state designs that give mobility, flexibility, reliability under military conditions: VERDAN, for missile check-out, airborne and submarine weapon systems; FADAC, for artillery fire control and support computations. These systems help keep America's military computer capability foremost in the world.*

*Electromechanical systems by* **Autonetics** *A Division of North American Aviation*

# Swedes Develop Versatile Air Rockets

***close support of ground troops as well as fighting aircraft are requirements of Bofors, SAAB systems***

**by Bernard Poirier**

TWO SWEDISH FIRMS have developed a number of versatile air-launched missile systems using both highly specialized air-to-air weapons and domestic rockets designed to destroy both land and air targets.

Responsible for the systems are AB Bofors and Svenska Aeroplan AB (SAAB). The platform, electronics and computers are supplied by SAAB; Bofors provides the last stages—rockets and warheads.

For the high-performing "Lansen" and "Draken" fighter/attack aircraft, SAAB perfected an All Weather Gun Sight (infrared and optical), a Fire Control system with Ballistic Computers for collision course tactics or lead pursuit attacks.

Essential to the aircraft's attack potential is reliability of optics, infrared detection and radar readings and read-out. Bofors, meanwhile, developed three rockets whose propulsive reliability and aerodynamic capabilities would react quickly and surely on the heels of command impulses from aircraft-contained guidance computations.

Bofors rockets—the *M 55* (7.5 c.m.), the *M 56* (13.5 cm.) and the *M 57* (7.5 cm.)—are essentially the "stingers" of a system whose entire guidance structure is contained for future use within the carrier-aircraft. The firing dispersion is small, accenting accuracy. In tests at 1200 yds., dispersion has been less than 4 yds.

For daytime, clear weather air interceptions, the SAAB system utilizes optically orientated information correlated to artificial aiming mark and artificial horizon plus range data. For interceptions at night or in clouds, target information is relayed via external angular-tracking radar or from infrared detectors. A complete airborne electronic package weighs 130 lbs. and requires 1.5 cu. ft. There are 74 miniature and sub-miniature tubes with 107 tube functions.

Information from the optical sighting head is generated electronically on the screen of a projector-type cathode ray tube. Information gathered from radar or infrared readings follows the same course through an amplifier whose program merges the findings with aiming mark and horizon.



*THESE ROCKETS designed and built by AB Bofors are an attack armament version of 13.5 cm air-to-ground rockets of a new type. Twelve rockets, six under each wing, can be carried by the SAAB-35 "Draken."*

Svenska Aeroplan engineers describe their Ballistic Computer as one whose settings are established prior to take-off in an outside switch panel to adjust for the aircraft's particular armament. They say, "The Ballistic Computer receives range, air data and attitude signals, and generates for the armament selected the currents necessary. It contains several function generating servos, each consisting of flat, nonlinear potentiometer cards and a common servo-driven wiper arm."

• **Disadvantage to Collision Tactics** —Lead pursuit interception is similar to former dogfight tactics except for the electronics necessary with today's high speed aircraft. Features of head-on or collision course tactics are "less strain on the pilot" resulting in more accurate human reactions, the "time gain" as the fighter comes in and the "disadvantages" presented to the enemy who can not loosen defensive weapons efficiently due to high angular velocity of sight, high closing velocity and the ballistics of crosswind shooting.

The Fire Control system already contains the rocket characteristics fed into it prior to take-off. Function signals from the radar, air data system and central gyro platform are received into the electronics system to determine the firing sequence of the rockets.

Collision source tactics are described as deadly but some limitations are evident. The enemy aircraft is easily placed into a pattern where he can be destroyed as easily as a pheasant in the open. A complete rocket salvo is needed in this operation, leaving a pilot with little choice other than to make his presence limited to the vicinity of battle, just in case. The company itself points this out.

SAAB's ballistic computer is the analog type, working with 400 cps AC signal voltage.

The Bofors *M 55* was designed primarily for combatting medium or heavy bombers. It has high velocity,

little dispersion, low weight and a large bursting charge. Velocity at 32,000 ft. altitude is 2624 ft/sec.

The fuze is the highly sensitive instantaneous direct-action type with shutter, delayed safe arming and self-destruction devices. The bursting charge is described as "0.75 kg. Hexotonal (TNT/RDX/A1)." The propellent burns for 0.9 sec. Its double-base powder is temperature-compensated; at —60°C the burning time is increased by 10%, at +50° C it is reduced by 20%.

There is insulation between the motor tube and combustion chamber so the casing exterior maintains original temperature during burning time. The fins are slotted to form the rear suspension points for the rocket underneath in a rocket stack. The nozzle has a sealing washer.

Moveable shear pins hold the rockets in position. Thirty-two rockets can be fired in .3 sec. in salvos of 8, or in .42 sec. in salvos of 4. When the firing button is pressed an automatic transmitter discharges firing impulses.

The *M 56* was designed for use against surface targets. It has a 5 5/16 in. diameter, weighs 90.4 lbs. and is almost 6 ft. long. Velocity is 2130 ft/sec. The 50% radial dispersion (R50) is about 4 mils when firing in series. The warhead weighs 39.7 lbs. and the TNT charge accounts for 20% of the weight. It will pierce 1 3/16 in. iron plate or about 1 in. armor plate at a 60° impact angle. The double base propellent burns for 2 secs.

Bofors modified the *M 55* to develop a pod-firing rocket with a new electrical system and a retaining spring design. In this case, the retaining spring is sheared off at firing. The pod-firing rocket is the *M 57*. It has seven folding fins replacing four fixed fins. The new *M 57* can be fired more quickly—at intervals of 10-20 millisec., depending upon the value for which the interval transmitter in the pot has been set. ⌗

## First European Space Technology Symposium Set

The British Interplanetary Society will hold the first European Symposium on Space Technology in London this June.

Its purpose is mainly to bring together engineers and scientists from Western Europe to discuss the possibility of formulating a joint program of space research. It will be open to participation by countries in Western Europe, particularly those belonging to the Organization for European Economic Cooperation, and will be aimed primarily at industry.

Besides considering technical projects, the Conference will deal with matters of finance and organization.

# New Automatic Radar Sighting System Unveiled

**by Anthony Vandyk**

LONDON—The Ferranti Airpass II radar fire-control and bomb aiming system was unveiled here last month. Designed for use in modern dual purpose interceptor/strike aircraft, it was developed as a private venture by Ferranti Ltd. In Edinburgh, Scotland, where the original Airpass I is now in quantity production for the Royal Air Force's English Electric Lightnings.

• **Installation**—Airpass I is purely an interception system designed for the English Electric "Lightning." It consists of a very advanced Radar equipment and a sighting system, the Pilot's Attack Sight or P.A.S. This is a "head-up" gyro sight designed for both visual and "blind" attacks and an identical sighting head is used in Airpass I. The Airpass II radar also has many similar features. In particular the principle of a self-contained inter-changeable nose-pack is retained, saving weight and simplifying front-line servicing.

Airpass II provides for largely automatic navigation and weapon-aiming by day or night on interception, ground-support or long-range strike missions yet the size and weight are little more than those of Airpass I. Airpass II can be installed in most interceptor and strike aircraft and has been specified for the export versions of the English Electric "Lightning," the Dassault "Mirage III" and the SAAB "Draken."

• **Interception**—The radar, which is stabilized in pitch and roll, scans a sector of sky covering a wide angle in elevation and azimuth on either side of the flight path and extending many miles ahead of the fighter. Once a target is located and seen on the Search Display the radar is locked-on and begins to track. This process can also be initiated, of course, if a target is detected visually.

Once the scanner has locked-on, a computer in the radar Unit automatically works out the best approach course for the pilot to follow in order to reach a suitable position for attack with guns, rockets or guided weapons. Steering signals from this computer are presented on the Pilot's Attack Sight in the form of an Aiming Mark and Target Spot.

On completion of the approach the P.A.S. automatically ensures that the weapons are correctly aimed even though the target may be still invisible to the pilot. At the same time the attack can easily be completed visually if the target should come into view, since the pilot is already looking forward out of his cockpit through the sight. An automatic warning lamp is also incorporated on the side of the P.A.S. to tell the pilot when to break off the attack if he should approach close enough to be in danger of colliding with the target.

• **Air-To-Surface Attacks**—In good visibility all types of surface target may be attacked with guns, bombs or rockets using the Pilot's Attack Sight for aiming, with target range being fed automatically from the radar. Certain targets such as ships, which return a clear radar echo, can also be attacked "blind." Conventional bombing is by the "dive-toss" method, but if it is required to make prepared attacks against targets whose position is known, Airpass II can be provided with a Navigation Computer and Bombing Computer designed for "long-toss" bombing. Alternatively for visual attacks the pilot can fly directly over the target and use an "over-the-shoulder" bombing maneuver.

In all bombing attacks the correct aircraft path is calculated in the Bombing Computer and steering signals are presented on the Pilot's Attack Sight. These allow the pilot to maintain the required course during the bombing run, taking account of any corrections necessary for wind and aircraft speed. These corrections are fed in from Doppler radar if this is available or the wind data can be estimated by the pilot and pre-set on his switch panel.

• **Navigation And Low Flying**—The Approach to surface targets will often be made at very low level beneath the coverage of ground radars. Airpass II has, been designed to be capable of giving the maximum help in navigation and low flying.

In the Ground Mapping mode the radar scanner is stabilized in pitch and roll and the pilot sees a P.P.I. radar map of the terrain ahead on his Search Display. He can compare this with his normal map and check his navigation even if he cannot see the ground. In addition, if the Navigation Computer is carried this can identify the target and provide steering signals to it for presentation on the P.A.S. display.

In the Contour Mapping (or Terrain Avoidance) mode the radar scans to and from on either side of the aircraft's flight vector. The radar Search Display shows also any hills scanned by the radar beam.

## Lockheed Missile Business Up

More than half Lockheed Aircraft Corp.'s $1.3 billion business in 1960 came from missile and space business, underscoring the current trend in the aerospace industry.

Thirty percent of 1960 sales came from *Polaris* ballistic missiles, according to a year-end report by Chairman Robert E. Gross. Gross also disclosed that the first launchings of the extended range *A-2* and *A-3 Polaris* models will take place this year.

*Agena* satellite vehicles and other space research brought more than 22% of the company's business for the year. Lockheed noted that it has orders which will bring the number of *Agena* satellites in 1961 to more than those orbited by the United States and USSR combined in 1960.

The company forecast new uses for *Agena* in Project *Advent*, and in *Saint*, an Air Force project being directed by RCA for inspection of unidentified satellites.

Aircraft's portion of Lockheed's total sales show a steady decline from 94% in 1955 to 43% in 1960. All missile sales at Lockheed five years ago accounted for less than 4% of total business.

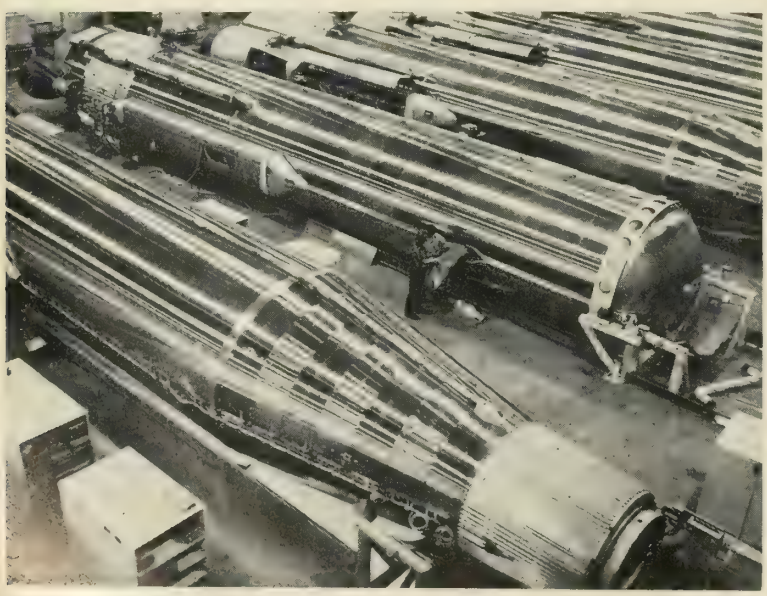
**Martin Company**—The missile and space company disclosed that record sales and earnings will probably be reported for 1960 and that 1961 sales will probably continue the trend.

The company, which recently moved out of the aircraft business by delivering its last P5M-2 to the Navy, has in production *Titan, Pershing, Mace, Bullpup* and *Lacrosse*.

**Emerson Electric Mfg.**—Highest sales and earnings in the history of the company were reported for the fiscal year ended Sept. 30. Consolidated sales were $125.5 million, including sales of $24.5 million of Day-Brite Lighting for the full fiscal year. This compares with sales of $91.5 million for the previous year when Day-Brite was not a subsidiary. Earnings were $6 million, with almost $1 million attributed to Day-Brite. Net earnings the previous year totaled almost $4 million. Sales of defense products totaled $41.6 million, an increase of 21% over sales of $34.2 million the previous year.

**Yardney Electric**—Six-month sales reached $4.8 million, compared to $3.3 million for the same six months of 1959.

**Bendix Corp.**—Sales, royalties and other operating income for the 1960 fiscal year ended Sept. 30 were $792.3 million—15% over the previous year's total of $683.8 million. Net income amounted to $26.2 million compared with $27.4 million in 1959.



*CENTAUR BOOSTER (center) goes into final assembly at Convair's San Diego plant amid conventional Atlas airframes. Atlas-Centaur vehicle, which will be flight tested this year, holds more fuel because of untapered configuration.*

## Corporate Changes

**RADIATION INC.** has changed the name of its subsidiary Levinthal Electronic Products, Inc. to Radiation at Stanford. Radiation at Stanford will combine the activities of Levinthal Palo Alto, and Radiation's Space Communications Division presently at Mountain View. The company's Palo Alto facilities will be expanded to accommodate the Mountain View division and increased West Coast operations.

**STRATHAM DEVELOPMENT CORPORATION,** a wholly owned subsidiary of Statham Instruments, Inc., has been merged with the parent company and will be known as the Electronics Division.

**BURTEK, INC.** has acquired Concord Control, Inc., of Boston from the Giddings & Lewis Machine Tool Co. of Fond Du Lac, Wis., and the officers of Concord.

**CALIFORNIA EASTERN AVIATION** through its subsidiary Land-Air, Inc., has acquired Automation Controls Corp. Automation Controls has been integrated into the Steppers Motors Division of Land-Air.

**DORSETT ELECTRONICS LABS, INC.** has purchased all the outstanding shares of American Missile Products, Inc. of Lawndale, Calif. American Missile formerly was the electronics division of the Maytag Company, Newton, Iowa.

**WESTINGHOUSE ELECTRIC'S** aircraft equipment department located at Lima, Ohio, has been renamed the Aero-space department. The group has been active in the space field for about two years.

**DEFENSE INFORMATION INC.'s** Undersea Technology Department has formed a Anti-Submarine Warfare Technical/Management Directory Service listing the technical, functional or operational responsibilities of more than 300 desks in Washington, D.C., concerned with undersea technology. Donald E. Perry, former managing editor of MISSILES AND ROCKETS, heads the department.

**DOW CHEMICAL CO.'s** Industrial Service Division has formed a "missile task force" to coordinate all chemical cleaning of missile system components. The cleaning facilities had been supervised by three separate district offices which also had responsibility for chemical cleaning operations in strictly industrial applications.

**GENERAL ELECTRIC** has dedicated its new $8-million Syracuse Industrial Center Plant. The ultra-modern 465,000-sq.-ft. engineering and manufacturing facility will be used by the company's Heavy Military Electronics Dept.

**MOTOROLA, INC.** has moved into new corporate headquarters in Franklin Park, Ill. The new $7.5-million structure will house the company's corporate executive offices in addition to its Consumer and Automotive Products divisions with their respective engineering, developmental and research facilities.

**CONVAIR DIVISION** of General Dynamics Corp. is moving its Dynapak facility from Pomona to San Diego this month. The facility manufactures high-energy rare metal-forming machines and a line of advanced mechanical test equipment.

**TEMESCAL METALLURGICAL CORP.** has moved its offices and plant from Richmond, Calif., to a new location at Berkeley. The company has a new electron beam furnace under construction at the Berkeley site which will stand approximately three stories high and will weigh nearly 25 tons.

**ROCKETDYNE DIVISION** of North American Aviation, Inc., has established a separate subdivision for reliability in Liquid Propulsion Operations. Dr. C. C. Davenport will direct the program.

**WYMAN-GORDON CO.** has almost completed a $3 million expansion of beryllium facilities with the enlargement of present processing quarters. Transfer of precision forging equipment to Worcester, Mass. from Franklin Park, Ill. is almost completed.

**NORTH AMERICAN AVIATION** has changed its Missile division to Space and Information Systems division. At the same time the division will accelerate the development of the *Hound Dog* and more of the corporation's work on manned and unmanned space exploration vehicles, anti-ICBM projects and management of information processing systems will be concentrated there. Some 25 or 30 persons from other company space projects will join the 6400 employees who have been in the division.

**THOMPSON RAMO WOOLDRIDGE** has obtained an option to acquire more than 90% of Radio Condenser's common shares through a stock exchange. The acquisition would add a completely new product line to TRW's Electronic Components Group.

**ELECTRONIC MATERIALS CORP.** has been formed to prepare and conduct research and development studies in advanced materials for Space Age technology. The Santa Monica firm will be headed by Dr. R. C. Vickery and H. M. Muir.

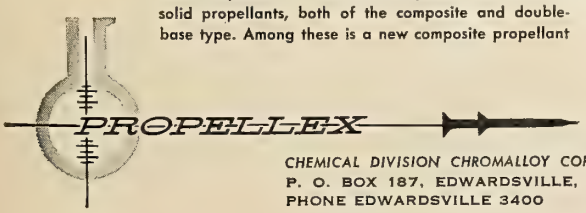
**CRYOMETRIC CORP.** has been organized in La Jolla, Calif., to specialize in instrumentation needs in the field of cryogenics. The firm will have an R&D laboratory in Los Angeles and subcontract initial manufacturing to another firm.


# BULK ORGANIC NITRATES

- **PGN** ... polyglycidyl nitrate
- **TEGDN** ... triethylene glycol dinitrate
- **PeTriN** ... pentaerythritol trinitrate
- **TMETN** ... trimethylol ethane trinitrate
- **BGDN** ... butylene glycol dinitrate
- **DEGDN** ... diethylene glycol dinitrate

The above explosive and high-energy plasticizers for solid propellants are now available (in any quantity) from Propellex. In addition, Propellex manufactures solid propellants, both of the composite and double-base type. Among these is a new composite propellant that combines high energy with extremely low sensitivity to temperature changes.

For nitrated chemicals, propellants, explosive and ignition materials, plus other specialty chemicals . . . contact Propellex. Prices on request.




CHEMICAL DIVISION CHROMALLOY CORPORATION
P. O. BOX 187, EDWARDSVILLE, ILLINOIS
PHONE EDWARDSVILLE 3400

**IMMEDIATE DELIVERY**

WEST COAST OFFICE:
4609 Staunton Avenue
Los Angeles 58 • ADAMS 2-6191

Circle No. 10 on Subscriber Service Card.

# Hoegh Disputes Military 'Takeover'

***Novelist Pat Frank's description of the state of the nation's civil defenses in M/R last month prompts a sharply worded rebuttal from retiring CD Director Leo Hoegh, who feels Frank is dead wrong. For an answer to the rebuttal and some reader comments see next page and page 48.***

PAT FRANK'S SUCCESS as a "nuclear war" novelist is due to his knowledge of the subject and his vivid imagination. But in some opinions expressed in his article on civil defense ("Kennedy Should Put Civil Defense Under Military," M/R, Dec. 12, p, 16), I think he's wrong. This is why:

1. He implies that, under the Symington Plan (Report to Sen. Kennedy from the Committee on the Defense Establishment), all of civil defense would be placed under the military. This is apparently mere conjecture. The report said: "There should be established a unified Command in charge of the National Guard and Reserve elements of all of the Services. In addition to its other functions, this command would be responsible for Civil Defense, and would report directly to the Chairman of the Joint Staff." According to its Executive Director, Dr. Edward C. Welsh, the Committee meant to suggest by this only that *military activities* regarding civil defense should be strengthened and centralized. No decision was made, he says, regarding a takeover of civil defense by the military. He acknowledges that policy direction would certainly have to come from outside the Pentagon.

2. If any reorganization does come about, it is unlikely to ignore the views of the military. On *direction* of civil defense, the military position has long been clear: Defense has a primary mission—combat. The question of who should direct civil defense is not new. The function was taken out of the War Department during World War I and was under civilian control in World War II. In 1948 the War Department's Civil Defense Board stated flatly that the major civil defense problems are outside the scope of military responsibility because "such problems are civilian in nature and should be solved by a civilian organization which would plan, operate and supervise civil defense in all of its phases." Such a civilian organization was eventually created, and these functions now are performed by the Office of Civil and Defense Mobilization, part of the Executive Office of the President. The military agrees that this is a proper assignment.

This does not mean there is no place for the armed forces in civil defense *operations*. The role of the military, explicity spelled out in Annex 7 to *The National Plan for Civil Defense and Defense Mobilization*, and in DOD directives, is that "military support to civil authorities in civil defense operations is an emergency task within the mission of all Federal active duty and reserve units of the military services, to be performed when essential military requirements will permit." The Commanding General of the U.S. Continental Army Command has emphasized this role, and the necessary training for it, to the army commanders. These policies now appear in the Supplement to the Army Strategic Capabilities Plan.

Assistant Secretary of Defense Charles C. Finucane, in a DOD policy statement before the House Military Operations Subcommittee this past April, declared, "Civil defense must remain under civil authority in accordance with the policy and intent of the Congress expressed in the Federal Civil Defense Act of 1950 as amended."

"Military assistance," he added, "is complementary to but not a substitute for civil participation in civil defense. It would, therefore, be extremely hazardous to assume that the military could meet a substantial share of the civil defense requirements while simultaneously conducting necessary military operations. An effective civil defense plan must include the civil population at large in civil defense operations to assure the survival of the Nation and its military power."

3. There is much more to civil defense today than patching up people and their property after an attack while maintaining some semblance of order—and even that would be too big a task for the military. It is prepared to help, but it recognizes the impossibility of doing the job alone. Much more suitable are the seven millions of government employees —Federals, State and local. It has long been our aim to make full use of government personnel and resources in emergency.

Also, civil defense involves preparing the people to protect themselves against attack, insuring the capability of government to function, safeguarding the people's rights, preserving and allocating resources, maintaining an adequate economic system. This is the business of all government, not just the military.

4. "In the event of nuclear attack on the United States," says Mr. Frank, "martial law would be declared instantly, so in a crisis civilian defense would be subordinated to the military in any case." This presumption ignores the effects of current preparations for strengthening continuity of government at all levels in order to avoid the necessity for imposing martial law. The military would give priority to support of civil authorities in maintaining law and order.

The term is not universally understood. Martial law is a last resort, not an automatic act; it cannot be imposed without specific executive authorization. And no one is more wary of its consequences than the military.

5. Turning from organization to activities, Mr. Frank asserts: "Drastic revision of present civil defense tactics must take place to give the people a realistic hope for survival." One such "drastic revision" he proposes has been national policy for two and a half years: "an adequate home shelter program, privately financed with Federal encouragement."

The "National Policy on Shelters" statement, issued at the President's direction on May 7, 1958, declared that "in the event of nuclear attack on this country fallout shelters offer the best single nonmilitary defense measure for the protection of the greatest number of our people." To implement this policy, OCDM has been educating the people on attack effects and protective measures (for example, millions of family fallout shelter plans have been distributed), surveying existing shelter, constructing prototypes for public inspection, and developing even better shelter techniques. Leadership and example through inclusion of fallout shelter in new and existing Federal buildings have been stymied by the almost total failure of the Congress to appropriate funds. This is one indication of the responsibility for what Mr. Frank calls "the budgetary brushoff given Civil Defense."

6. While his emphasis on shelter is commendable (if not original), his disdain for evacuation does not logically follow. At the right time and the right place, evacuation may be the best course. As long as it may save lives, it must remain a possible alternative to shelter. Also, it is not necessarily a matter of choice between the two; a combination of them may be best. At any rate, the action to be taken is a local decision, for the local authorities alone can weigh all of the many factors involved. Until an area has enough shelter space, and perhaps even then, it may be wiser, if time permits before an expected attack or arrival of fallout from an attack upwind, to move to a relatively safer place. Civil defense planning rightly stresses shelter, but not to the exclusion of evacuation.

7. Among his other proposals is one to scrap the Conelrad plan for reducing navigational aid to the attacker by re-

stricting emergency broadcasting. Contrary to Mr. Frank, the Air Force maintains that, since bombers would probably be used even in a so-called missile attack, Conelrad is still needed. Further, the system is steadily being improved so that everyone will be in range of instructions broadcast during the attack period over 640 or 1240 kc on AM radio.

8. As for the vulnerability of wire service facilities and its effect on dissemination of news, the situation is again not so bad as pictured. NACOM 2, the Government's National Radio Communications System, provides backing for landline communications (NACOM 1) at all OCDM and State operational headquarters. This would be available to news media, subject to higher priority needs of government.

9. Mr. Frank's comments on the reasons behind public "unalarm" are apt, but his view of the extent of this apathy is exaggerated. He ignores the great and increasing number of citizens who participate in local civil defense activities, who inquire about what they should do and how they can help, and who have built fallout shelters and taken other recommended survival measures.

There are *no* "policies designed to play down the horrors of nuclear war," as should be evident from the vast amount of information OCDM and other agencies have made available and actively sought to get to the people. Apathy stems less from ignorance of the facts than from the desire to ignore those which are unpleasant. To say that the government has attempted to encourage this attitude is totally unfounded.

10. One last point, of lesser importance, perhaps, compared with these others, but nonetheless deserving of mention: the integrity and capability of those entrusted with these aspects of national defense. Mr. Frank does a disservice to these men and women, dedicated to their country and fully cognizant of the importance of their work.

I hope you will grant space in your publication for this presentation of "the other side" to Mr. Frank's story.

Leo A. Hoegh
Director
Office of Civil and Defense Mobilization
Washington

## *FRANK'S REPLY TO HOEGH*

MR. HOEGH SAYS that I have a vivid imagination. I hope so. It has been the absence of imagination in the highest levels of government, as well as lack of appropriations, that is responsible for our supine civil defense. Mr. Hoegh ignores the one terrible fact implicit in all-out nuclear war: The primary target of the enemy would be the United States and its people. Therefore the protection of the people becomes a primary responsibility of the military.

The present Civil Defense setup, as Mr. Hoegh points out, was based on a 1948 Defense Department decision that "major civil defense problems are outside the scope of military responsibility." In 1948 the Russians had not yet ex-

*(Continued on page 48)*





# INERTIAL QUALITY

## SINGLE AND 2 AXIS ACCELEROMETERS

Highly precise and accurate, Kearfott's accelerometers are pendulous devices which sense airframe acceleration forces acting on them.

A pendulum utilizing a unique Hooke's joint suspension displaces as a function of acceleration. An AC pickoff signal is rectified and applied to voice coils restoring the pendulum to null. The DC required for restoration is proportional to acceleration. Typical characteristics for these units include range of ±25 g's, scale factor of 5.0 ma/g, linearity of ±0.005% and threshold of 2 x $10^{-7}$ g's.

| CHARACTERISTICS: | SINGLE AXIS | SINGLE AXIS | TWO AXIS |
|---|---|---|---|
| TYPE NO. | F2401 | 429037 | 326778-1 |
| Range of Measurement | ±20g | ±25g | See above |
| Scale Factor (output) | 5.0000 ma/g | 5.0000 ma/g | |
| Operating Temperature | 155°F ±5°F* | 50°F and +160°F | |
| Threshold | 5 x $10^{-7}$g | Less than 2 x $10^{-7}$g | |
| Zero Stability | ±0.05 milliradian | ±.00005g day to day | |
| Vibration | Up to ±10g peak from 20 to 2000 cps | Up to ±5g peak from 20 to 2000 cps | |
| Storage Temp. | −65°F to +200°F | −60°F to +170°F | |
| Scale Factor Variation | ±.01% randomness | ±0.01% randomness | |
| Excitation | 6 volts, 3860 cps** | 6 volts, 4000 cps** | 3.4 volts, 4000 cps*** |
| Natural Freq. | 180 cps | 210 cps | 160 cps |
| Freq. Resp. | Flat to 250 cps | Flat to 160 cps | Flat to 100 cps |
| Shock | 60 g's | 30 g's | 30 g's |
| Weight | 4 oz. | 7 oz. | 2 lbs. |

*Available for 180°F.
**Carrier frequency to 100 Kc may be used.
***When tested with Kearfott A3501-01 amplifier.

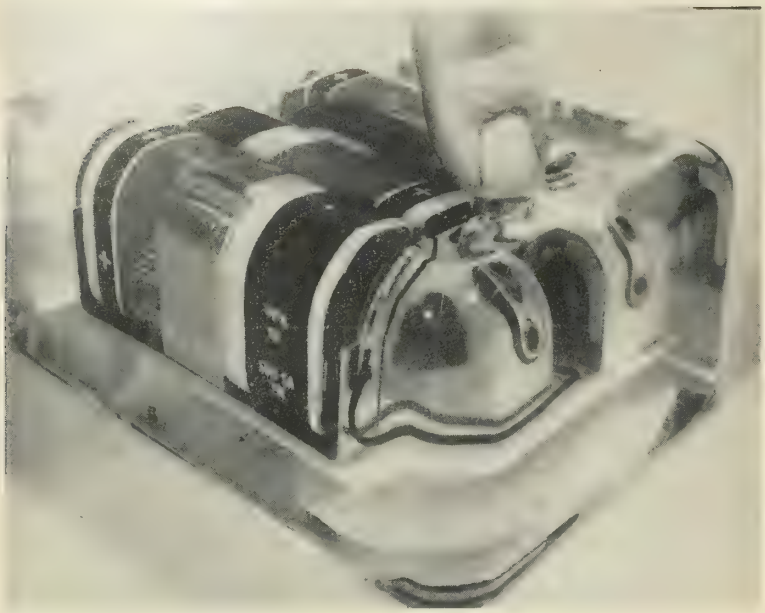
*Write for complete data*

KEARFOTT DIVISION
GENERAL PRECISION, INC.

*Little Falls, New Jersey*




Circle No. 11 on Subscriber Service Card.



## Clear Silicone Plotting Compound

A clear silicone potting and embedding compound that provides mechanical and dielectric protection for electronic components is available from the Silicone Products Dept. of General Electric. Designated LVT 602, it cures at 70° to 80° C to a flexible solid.

LTV-602 provides protection against shock, vibration, moisture, ozone, and other environmental hazards of the space age. The cured material is self-supporting and non-flowing, providing for ease of handling as well as continual exclusion of dust and other contaminating particles.

Because of its low viscosity in the uncured form (800 to 1500 cp), LTV-602 flows freely in and around complex parts. Delicate components are not damaged by stress during cure.

Circle No. 225 on Subscriber Service Card.

## Ceramic Fiber Insulation

Fiberfax (R) ceramic fiber, a high temperature insulation, is available from the Carborundum Co.

The fibers are fabricated into over 40 forms such as blocks, sheets, paper, textiles, blankets, rope, castables and moulded forms. The light material withstands continuous operating temperatures up to 2300° F.

Circle No. 226 on Subscriber Service Card.

## Dual Liquid Head Valve

Variable system pressures do not affect the function of a differential-level pilot valve available from Besler Corp. The valve operates on the difference between two columns of liquid, usually between a constant reference head and a variable head.

As the level rises in the variable column the Besler differential level pilot valve opens and releases air pressure from the top of a diaphragm motor valve, allowing the discharge of liquid from the variable column. When the level in this column falls to a pre-determined level the valve again closes, and the cycle repeats.

Circle No. 227 on Subscriber Service Card.

## Skidless Surface Measure

Because of the increased demand for equipment capable of measuring surfaces too small to permit both the pickup skids and diamond stylus to be located on one part, Cleveland Instrument Co. is marketing skidless pickup models designed to measure very narrow or small areas, such as flanges, thread flanks, gear teeth, and small internal diameters, as well as "O" ring grooves.

The Model BK 3922F Precision Slide makes possible surface measurements without skids—the reference line, normally provided by the skids being generated by the slide.

Model MP 0002SL General Purpose Skidless Pickup is for the measurement of small I.D.'s and O.D.'s, flanges, thread flanks, gear teeth, or other applications where limited area measurements exist. With this equipment measurements can be made to within 0.020 in. of the shoulder.

Circle No. 228 on Subscriber Service Card.

## High Capacity Data Switch

Through the use of printed circuits and modular type construction, Instrument Systems Corp. has developed a compact high capacity data switch for multi-contact temporary or permanent switching. A representative model has 40 single-pole switches, each of which can be manually positioned to select one of 56 contacts on glass fiber laminated printed circuit boards.

Circle No. 229 on Subscriber Service Card.

## Test Table Leak Detector

A test table designed to make production leak detection a fast, foolproof operation is available from General Electric for mass spectrometer leak detectors.

An accessory that attaches directly to the mobile G-E leak detector, the unit is intended to expedite production testing of capacitors, transistors, vacuum tubes, and nearly any other large or small device when minute leaks must be detected.

Circle No. 230 on Subscriber Service Card.

## R. F. Connectors

Designed for use with small size coaxial cables, such as RG-59B/U, a series of AN/MS Type connector



developed by National Connector Corp. uses irradiated polyolefin and polypropylene. Weatherproofed and designed for extreme reliability, even under abnormal conditions of stress, NCC's AN/MS series connectors may be efficiently used up through microwave frequencies with a minimum of line unbalance or increase in standing wave ratio. Unique design permits the

coax conductor to be soldered directly to the contact point within the connector body, greatly reducing the danger of accidental disconnection due to cable strain.

Circle No. 231 on Subscriber Service Card.

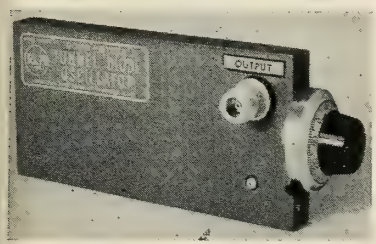
## Environmental Chambers

Conrad, Inc. has available four standardized production models of space environment test chambers. The sizes are 72, 48 and 36 in. diameter by 60 in. deep and 24 in. diameter by 30 in. deep. The chambers feature various accessory items such as rotary shafts, interior lighting, view ports and optional stainless steel liners. The chambers are equipped with mechanical and diffusion pumping systems. Pumping time, to 0.5 of a micron, range from 3½ minutes to 8 minutes depending on the chamber size. Higher vacuums are available on special order.

Circle No. 232 on Subscriber Service Card.

## Tunnel-Diode Oscillators

Two stable microwave oscillators utilizing tunnel diodes in specially de-




signed circuits are available from Radio Corporation of America.

The SS-100 is mechanically tuned over its 1050-1400 Mc range. The center frequency of the SS-104 is specified by the user in the 800-1400 Mc range. It can be electronically tuned over a total range of 5% of its center frequency by varying the dc input voltage.

Circle No. 233 on Subscriber Service Card.

## Broadband Isolator

A broadband isolator providing minimum isolation of 30 db with a maximum VSWR of 1.10 and a maximum insertion loss of 1.0 over the entire X-band frequency range, from 8.2 to 12.4 Kmc/S, is available from E & M Laboratories.

Circle No. 234 on Subscriber Service Card.

## Al-Si Rubber Glass Cloth

Protection of equipment and personnel from high radiated heat is possible with an aluminized silicone rubber coated glass cloth available from the Irvington Division of Minnesota Mining and Manufacturing Co.

"Irvington" brand aluminized fabrics SRGA 0208 and SRGA 0214 are 0.008 and 0.014 inches in caliper, weigh 10 and 14 oz./sq./yd. respectively, are suitable for use in continuous ambient temperatures ranging from —100° to 500°F., and for short periods of 700°F. The fabrics are available with the plain silicone rubber coated side either cured or uncured. Special treatment makes it possible to bond either side under heat and pressure for applications where this is desirable.

Circle No. 235 on Subscriber Service Card.

## Magnetic Storage Drums

Instrument Systems Corp. is marketing magnetic storage drums. A typical item includes 4 channels, two of which provide adjustable delays of up to 6 seconds accommodating either complex waves or pulses. The unit utilizes a synchronous drive motor and special hydraulically damped gear box which results in smooth and uniform drum motion.

Circle No. 236 on Subscriber Service Card.

## Speed Sensitive Switch

The Cosmodyne Corp. is manufacturing a wide temperature range, speed sensitive switch S-10. Rated performance for the unit is a switching error not to exceed 1.5% of the rated speed over all environmental conditions. The unit may be supplied with as many as three either normally open or closed switched allowing for as many as three speed settings.

Circle No. 237 on Subscriber Service Card.

## Frequency Converter Units

A versatile plug-in unit which increases the measuring capability of -hp- Model 524 Electronic Counters to 510 MC is available from Hewlett-Packard Co. Model 525C contains a capacity-loaded cavity for frequency determination and a highly-efficient diode harmonic generator plus a transistorized amplifier. A "go-no-go" meter on the front panel shows when the signal has enough amplitude for frequency measurements.

Circle No. 238 on Subscriber Service Card.

## Telephone Data Transmission

Digitronics Corp. has available a Dial-o-verter System, operating in connection with the Bell System's Data Phone 200 subset, makes possible the rapid transmission of punched card paper tape or magnetic tape data over regular toll telephone lines. With the instrument, as many as 27,000 alphanumeric characters can be sent during a three minute phone call.

Circle No. 239 on Subscriber Service Card.

## Radiation Analysis

A transistorized spectrometer which automatically distinguishes between background radiation and the radioactivity of the object being analyzed is available from the Victoreen Instrument Co. The instrument has 200 data storage channels with total capacity of 20 million "counts."

Circle No. 240 on Subscriber Service Card.

## Male Port Metering Valve

A small globe type metering valve with male ports, 14,000 psi burst pressure, suitable for manometer pressure gauge or sampling use with gases such as air, nitrogen, oxygen, and helium is being marketed by Robbins Aviation, Inc.

The INS736 has an operating torque of 4 in.-lbs. at 2500 psi. Operating temperature range is –65° to 250° F. Weight is only 0.31 lbs.

Circle No. 241 on Subscriber Service Card.

## Projection Resistance Welder

The ability to encapsulate semi-conductor and transistor components by resistance welding over a wide range of sizes on one piece of equipment has been achieved by the Thomson Electric Welder Co. with their Model 2400 projection welder. This capacity range is realized by using twin 75 KVA transformers coupled to the welding head through balanced secondary circuits and a new welding head design.

Circle No. 242 on Subscriber Service Card.

## Telephone Circuit Tester

The Siegler Corp. has available an electronic instrument which can test telephone circuit signals with 14 times the efficiency of conventional methods.

The device is called a Swept-Band Transmission Measuring Set. It discloses if there is any defect in a telephone circuit. In some cases, the Swept-Band can also determine the type of defect and its location.

It requires 6 minutes to examine one telephone circuit by manual methods. The Swept-Band can test 14 circuits in the same time period.

Circle No. 243 on Subscriber Service Card.

## Parametric Amplifiers

A family of broadband, Mil Spec parametric amplifiers for applications at L. S. C and X bands is available from Texas Instruments. Among these is an S-band non-degenerate Model that gives bandwidths up to 75mc at 15 db gain.

The extra wide bandwidth has been achieved by double tuning of amplifier idler circuits. Noise figure, including

circulator loss, for the S-band model is 3 db over the frequency range of 2.8 to 2.96 Gc; gain variation is no greater than 3db over the Mil-spec temperature range of —40° to 50° C. The unit also meets the vibration requirements of MIL-E-5400D.

Circle No. 244 on Subscriber Service Card.

## Flexible Twin DC Supply

Two low voltage DC power supplies with floating outputs, are available from R-K Labs. One supply offers 2, 6, and 12 volts d.c., selectable. The other, 1-30 volts d.c., variable. Both at 200 ma. Output may be used separately or simultaneously. Case grounded panel terminal offers choice of grounding either positive or negative outputs of both supplies.

Circle No. 245 on Subscriber Service Card.

## Fast Plaster Tooling

A material and method for producing short run, low cost plastic faced plaster tooling in two hours or less is available from Rezolin, Inc.

The simple four-step procedure utilizes Rezolin 111 Surface Coat Compound, which permits continuous rapid fabrication with no drying or waiting between steps. End tool will operate at temperatures up to 385° F.

Circle No. 246 on Subscriber Service Card.

## Adjustable Sequence Timer

Acton Laboratories Inc., a subsidiary of Technology Instrument corp. is marketing a miniature adjustable sequence timer Model 4-23. The lightweight timer features micro adjustable cams that can quickly be set within 0.1% of the total period.

The adjustable time span is 1 second to 45 minutes. The timer will provide switch closures during and after powered flight. The current drain is less than 70 milliamps.

Circle No. 247 on Subscriber Service Card.

## Ceramic Capacitor

A Glenco micro-miniature ceramic capacitor, believed to be the smallest capacitor commercially available, is being marketed by Gulton Industries, Inc.

Maximum size of the capacitor is 0.1-in. square by 0.05-in. thick, with a rating of 30 WVDC. Capacitance values are available in the range from 10 to 220 mmf., with a maximum capacitance change of ±10 percent over the temperature range of –55° to 85°C.

Circle No. 248 on Subscriber Service Card.

## Film Transducer

Clark Electronic Laboratories is marketing a chemical film transducer in the 0-5,000-lb. force size. This unit is 1 in. in diameter, and changes its electrical resistance from 0 to 5,000 lbs. over 100,000 ohms, with only 0.0005 in. deflection at full load.

These units will withstand temperatures from –150° to 450°F continuously, and vibration and shock of high magnitude.

Circle No. 249 on Subscriber Service Card.

## Slab Shaped Delay Line

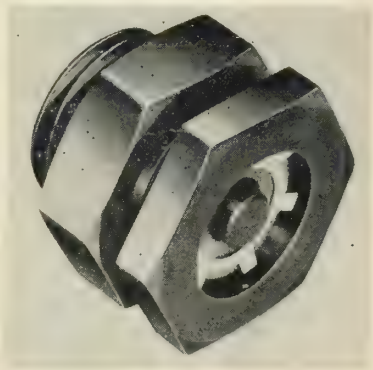
Deltime, Inc., has available a series of magnetostrictive delay lines, Type 158. They are of slab configuration to assist in high-density packaging of electronic equipment.

A maximum delay of 39 microseconds with up to nine additional outputs is available. Input pulse width is 0.8 microsecond with a maximum repetition rate of 625 kc. Insertion loss is approximately 50 db.

Circle No. 250 on Subscriber Service Card.

## Vent and Breather Valve

A compact combination vent and breather valve, PI-309, is available from James, Pond & Clark, Inc. Designed for



simple, single-hole mounting, the PI-309 will efficiently eliminate damaging internal and external pressure differentials caused by changes of altitude. By preventing diurnal breathing, the valve effectively prevents formation of condensed moisture in the container.

Circle No. 251 on Subscriber Service Card.

## Pressure Reducing Valve

Available in 4 and 6 in. sizes from OPW-Jordan Corp., a sliding gate and plate pressure reducing valve, air-operated, has capacity of 50,000 pounds of steam per hour or 2,500 GPM of water. Used to reduce pressure wherever large capacities, accurate control and tight shut-off are required, the system is suitable for pressures to 250 psi and temperatures to 500°F.

Circle No. 252 on Subscriber Service Card.

## Semiconductor Centrifuges

Lourdes Instrument Corp., has available special centrifuge rotors with cavities cut to conform to exact contours of diodes, transistors, capacitors and other semiconductors.

Relative centrifugal forces from 10,000 to 25,000 times gravity are secured, subjecting components to some of the effects encountered in space travel. Test results are quick and reproducible.

Circle No. 253 on Subscriber Service Card.

## Tungsten Arc Welder

A balanced wave, transformer type power source for use with tungsten arc welding equipment (Heliweld) is available from Air Reduction Sales Co. Designated the Airco C-Bee (capacitor balanced) Balanced Wave Heliwelder, this machine is exceptionally good for welding aluminum and magnesium using alternating current. It can be used with both manual and semi-automatic or automatic Heliweld equipment.

Circle No. 254 on Subscriber Service Card.

## Sub-Size Thermocouple

A sub-miniature fast-responding surface thermocouple is available from NANMAC Corp. with an overall well length of only 1.5 in. making possible a new variety of applications.

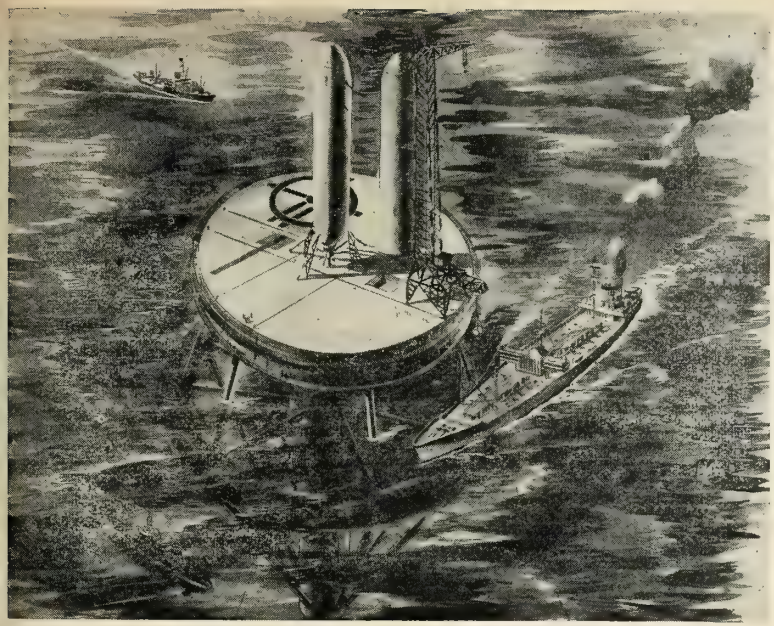
The thermocouple, Model D, features a response time of less than ten micro-seconds, a continuous service temperature of over 2000°F., an operating pressure range to 25,000 psi., and a sensing tip with unlimited life.

Circle No. 255 on Subscriber Service Card.

## Constant Mass Fan

A fan and motor coupled by means of a patented constant torque magnetic device providing an essentially constant mass rate of air flow over the operational altitude range of the cooling equipment on which the assembly is applied is available from Eastern Industries, Inc. Based on the principle of decreasing density of air with increasing altitude, the coupling permits the fan speed to vary directly with altitude or inversely with the square root with relative density of the air being handled.

Circle No. 256 on Subscriber Service Card.



## Seagoing Launchpad

*NUCLEAR ROCKET ready to blast off from floating launch platform as proposed by Aerojet-General Corp.'s AETRON Div. PROP (Planetary Rocket Ocean Platform) would be serviced by supply ships and submarine to evacuate personnel during nuclear activity.*

## Solar Storm Changes Orbit of NASA's Echo I Satellite

A great solar storm Nov. 12, the most severe since Feb. 23, 1956, produced a substantial change in the orbit of the 100-ft. *Echo I* balloon satellite.

Calculations by NASA's Goddard Space Flight Center indicate that atmospheric drag acting on the satellite increased by a factor of two for several days, during which time the orbital period was increased two seconds a day. Then the drag fell back to its previous level.

Dr. Robert Jastrow and Robert Bryant of Goddard's Theoretical Division, who made the calculation, indicated that the most likely cause of the drag increase is an increase in the average density of the very thin air through which the satellite moved, produced by the heating and subsequent expansion of thicker air at lower altitudes.

When launched Aug. 12, *Echo I* had a perigee of 945 statute miles and an apogee of 1049 miles. Currently, it has a perigee of 619 miles and an apogee of 1334 miles. Even though the atmospheric drag is extremely tiny at those altitudes, the effect is measurable on an object like *Echo,* which has a huge surface and weighs only about 150 lbs. ⌘

## STL Wins First Contract For Large NASA Satellite

Space Technology Laboratories, Inc., steadily moving free of its Air Force management commitments, has won its first major contract—for research and development of a big standardized satellite for the National Aeronautics and Space Administration.

The initial contract, for delivery of three flight spacecraft within three years, will total more than $15 million. However, NASA plans call for flying one or two Orbiting Geophysical Observatory (*OGO*) satellites a year for the succeeding five years. Thus follow-on contracts could bring the total to more than $50 million over an eight-year period (M/R, Sept. 12, p. 10).

*OGO* will weigh 1000 lbs., including up to 50 scientific experiments in modular sections, weighing 150 lbs. The design includes a potential of growth to 1500 lbs., including a 300-lb. piggyback satellite.

The spacecraft is designed for use with *Atlas-Agena B, Thor-Agena B* and *Centaur* launch vehicles. The first launching, programed for September, 1963, will be the Eccentric Geophysical Observatory (*EGO*), designated S-49, aboard an *Atlas-Agena B* down the Atlantic Missile Range. Nominal *EGO* orbital parameters will be: inclination 31°, perigee 150 nautical miles, apogee 60,000 nautical miles.

The second mission, programed for June, 1964, will be the first Polar Orbiting Geophysical Observatory (POGO), launched by a *Thor-Agena B* down the Pacific Missile Range, with a perigee of 150 nautical miles and an apogee of 600 nautical miles.

The satellite will be a rectangular parallelopiped about the size of a small coffin, six feet long and three feet square. Solar paddles six feet square and storage batteries will provide about 50 watts of power for experiments.

NASA hopes to fly *OGOs* on a "train schedule" basis, so that scientists preparing experiments will merely have to reserve space on the next satellite and deliver them to the launch site on time. This will greatly reduce the lead time built into early satellites, which had to be custom built.

NASA's Goddard Space Flight Center, Greenbelt, Md., will negotiate and manage the contract. Wilfred E. Scull of Goddard is project manager. Project scientists are Dr. George H. Ludwig for *EGO* and Nelson W. Spencer for *POGO.*

STL was chosen from eight bidders. The others were Aerojet-General, Bendix, Convair, General Electric, Grumman, Lockheed and RCA. ⌘




Circle No. 12 on Subscriber Service Card.



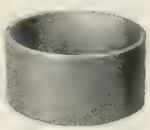
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### NASA

**General Electric's Missile and Space Vehicle Dept.**, an R&D contract for investigation of a means to store heat energy collected from the sun. The energy is needed to supply electrical power in satellites while they pass through the dark portion of their orbits caused by the earth's shadow. Amount not disclosed.

$50,155—**Chance Vought Aircraft, Inc.**, Dallas, for sounding rocket study.

### NAVY

$2,500,000—**Raytheon Co.**, Waltham, Mass., for industrial support to MIT in design and development of the *Polaris* inertial guidance system.

$1,400,000—**Genge Industries, Inc.**, Los Angeles, for engineering services, technical publications and documentation in support of NOTS.

$83,000—**Benson-Lehner Corp.**, Santa Monica, for design and manufacture of a high speed stereo camera and projection system for the Naval Weapons Laboratory.

### AIR FORCE

$3,000,000—**Motorola, Inc.**, Chicago, for microwave radar relay systems for 22 Air Force bases.

$620,000—**Avien, Inc.**, Woodside, N.Y., for limit detectors for the *Hound Dog* missile. Subcontract from **North American Aviation, Inc.**

$597,052—**Lockheed Aircraft Corp.**, Burbank, for ejectable nose capsule program.

$130,000—**Giannini Controls Corp.**, Duarte, Calif., for producing a key instrument for the *Minuteman* missile guidance system. Subcontract from **North American Aviation, Inc.'s Autonetics Div.**

### ARMY

$76,921,772—**The Martin Co.**, Orlando, for continued development of the *Pershing* missile system.

$20,943,120—**Hughes Aircraft Co.**, for four Missile Monitor operational "operations central" systems.

$14,980,526—**Raytheon Co.**, Waltham, Mass., for the *Hawk* program ($7,661,500 for procurement, $3,419,326 for engineering services, $2,399,700 for ground support equipment and $1,500,000 for technical manuals).

$5,273,370—**Land-Air, Inc.**, for data collection services at White Sands Missile Range.

$2,108,800—**Esso Research & Engineering Co.**, for additional funding in continuation of its advanced solid propellant research program.

$1,740,170—**R. E. Clarson, Inc.**, St. Petersburg, for construction of a precision trajectory measuring system at the Air Force Missile Test Center at Cape Canaveral.

$1,352,000—**Sperry Rand Corp.**, Salt Lake City, for research and development on the *Sergeant* missile system.

$1,200,000—**Fairchild Engine & Airplane Co.**, for additional funding on two SD-5 drones.

$1,033,974—**Chrysler Corp.**, for maintenance of *Jupiter* training equipment at the Army Ordnance Guided Missile School, Redstone Arsenal.

$151,044—**Firestone Tire & Rubber Co.**, Los Angeles, for replenishment repair parts for guided missiles.

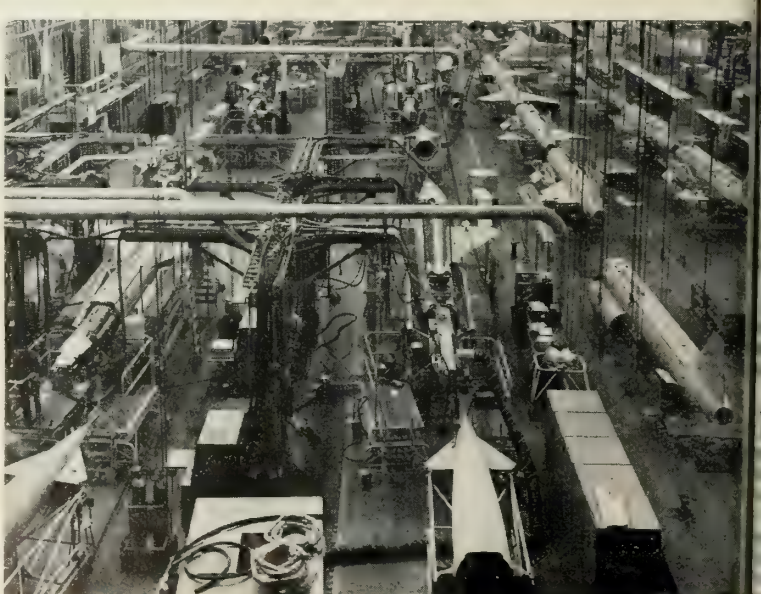
$124,477—**Plant Supervision Corp.**, Pittsburgh, N.Y., for construction of re-entry vehicle facilities.

$93,927—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* missile ground handling and test equipment. (Two contracts.)

$91,626—**Firestone Tire & Rubber Co.**, Los Angeles, for guided missile ground handling equipment.

$53,340—**Norris Thermador Corp.**, Vernon, Calif., for rocket motor.

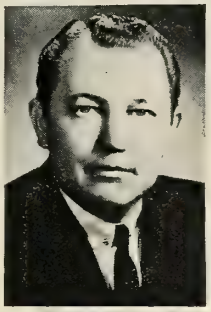
$28,588—**Aircraft Armaments, Inc.**, Cockeysville, Md., for design, development and fabrication of *Nike-Zeus* handling equipment.



*HOUND DOG air-to-surface missile operational with B-52 bombers is shown in production at North American Aviation. Turbojet-propelled bird has 500-mile range, Mach 1.7 capability.*

# names in the news


FORREST


MILLER


RABER


ALPERIN


MORRIS

**John H. Haughawout:** Appointed manger of the computer laboratory's advanced development department at Hughes Aircraft Co.'s ground systems group. Formerly served as manager of an advanced Navy computer project.

**J. A. Brustman:** Named manager, Electronic Systems Engineering of the Advanced Systems Development Engineering activity for RCA Electronic Data Processing Division. Prior to his appointment, Brustman participated in the design of a computer employing solid-state devices.

**Stuart M. Hauser:** Former assistant manager of Electro-Optical Systems, Inc.'s Advanced Electronics Division, appointed chief engineer at Electro-Optical Instruments, Inc., a separate company.

**Elby Martin:** Named marketing manger, Advanced Technologies, in Central Staff Marketing of Texas Instruments, Inc., succeeding **Richard C. Wood,** now manager of the industrial wire department of TI's Metals & Controls subdiary. Martin was formerly military relations manager in the Semiconductors-Components division.

**Melbourne A. Forrest:** Vice president Burns and Roe, Inc., elected to the board of directors. He will be responsible for the firm's project operations in power, nuclear, and industrial fields, as well as defense and aeronautical facilities.

**Noel S. Siegel:** Assistant to the president of New England Instrument Co., joins Electro-Tec Corp. as manager of marketing development.

**Albert J. Morris:** Elected president Radiation at Stanford, the newly formed subsidiary of Radiation Inc. Radiation at Stanford consolidates the former Levinthal Electronic Products, Inc., and the company's former Space Communications Division into one organization. Morris was senior vice president-engineering of the former Levinthal Electronic Products, Inc.

**Jack K. Walker:** Joins Packard Bell Electronics Corp. as director of product planning for the Defense and Industrial Group. Was formerly director of marketing and engineering at General Precision Equipment Controls, Inc., and director of marketing at Librascope, both subsidiaries of General Precision Equipment Corp.

**Robert E. Miller:** Formerly director of the Advanced Development Staff, elected to the newly created position of vice president for Advanced Development at Melpar, Inc.

**Meade C. Camp:** Named manager, Marketing Planning, of the Electronic Data Processing Division of RCA. Was formerly sales manager and manager of customer liaison for the Univac Division of Sperry Rand.

**Samuel Raber:** Joins the engineering staff of Dorne & Margolin, Inc., as Section Head of the Circuit Group. Was formerly associated with Fairchild Astrionics Division as a development specialist in the research division.

**Roger W. Fischer** and **William H. Smith:** Appointed engineering manager and marketing sales manager, respectively, for Undersea Technology at Avien, Inc.

**Robert C. Dunlap, Jr.:** Elected vice president of Texas Instruments Inc., succeeding **Fred J. Agnich,** who will continue as a member of the TI board of directors. Dunlap will be operating head of the company's geosciences activities and will continue to serve as president of Geophysical Service Inc., TI's wholly owned exploration subsidiary.

**Harold A. Wheeler:** Vice president and director of Hazeltine Corp. and president of Wheeler Laboratories, Inc., appointed to the Department of Defense Advisory Group on Radar.

**Frank E. Moddocks:** Joins the engineering office of Arthur D. Little, Inc., as a senior member of the business development staff. Was previously at the firm's headquarters in Cambridge, Mass., serving as a senior engineer in charge of a project to develop a fuel tank inerting and pressurization system for the B-70 "triplesonic" bomber.

**Clifford F. Abt:** Assistant research manager, promoted to manager of the Research Department, Arma Division of American Bosch Arma Corp., succeeding **Dr. Bernard Litman,** appointed to the division's newly created scientific staff.

**Dr. Morton Alperin:** Appointed chairman of the board of the recently formed CircuitDyne Corporation. Was formerly technical director and president of Space Systems and Industrial Automation, a subsidiary of Idaho Maryland Industries.

**David D. Terwilliger:** Named chief engineer of systems at the Precision Products Dept. of Nortronics. Prior to joining the firm, he was chief electomechanical engineer for Aircraft Armaments Inc.

**W. E. Gregg:** Former vice president-technology with Crucible Steel Company of America, appointed vice president-operations, succeeding **J. D. Dickerson,** who has taken over new administrative responsibilities.

**Ray W. Sanders:** Elevated to the newly created position of director of Satellite and Space Laboratories, Space Electronics Corp. Was formerly manager of the department.

**Bernard Reich:** Named president of Molecular Electronics, Inc., a subsidiary of Precision Circuits, Inc. Was formerly chief, Circuit Functions Branch of the Solid State Devices Division of the U.S. Army Signal Research and Development Laboratories.

**Dr. Thomas H. Johnson:** Vice president and general manager of the Research Division of Raytheon Co., elected to the board of directors of Technical Operations, Inc.

**Robert E. Bell:** Named district sales manager-Army Programs for General Electric Co.'s Heavy Military Electronics Dept., replacing **N. N. McIntyre,** assigned to GE's subsidiary in The Hague.

**Charles H. New:** Former research engineer with the Boeing Airplane Co., joins E D P Corp. as chief engineer.

## 'How many have home shelters?'

(Continued from page 41)

ploded their first test atomic device. In 1948 the USSR possessed only a rudimentary strategic air force and no ballistic missiles. In 1948 we did not confront the possibility that one-half of our population would be wiped out by surprise attack.

I believe Mr. Hoegh deludes himself if he believes his agency has educated the people, or even government officials, on what this country faces in the event of war, and what can and must be done about it. A few weeks ago I spoke before the Lake County (Florida) League of Municipalities. My audience consisted of mayors, councilmen, police and fire chiefs, and other municipal executives from a dozen towns. "You people," I beban, "are responsible for the survival of the citizens of Lake County should war come. I know that all of you receive, and read, a great deal of material from Washington on civil defense."

Most of them nodded in agreement.

"Now how many of you," I asked, "have a shelter in your home?"

Not one hand went up.

"And how many of you can tell me the name of the national Director of the Office of Civil and Defense Mobilization?"

Out of the fifty-odd people present, only one raised his hand.

### READERS' COMMENTS

IT WAS WITH great interest that I read the article entitled "Kennedy Should Put Civil Defense Under Military" in your Dec. 12 issue and wondered who the author, Pat Frank, was. The short biographical sketch at the end of the article clarified this completely.

This man should stick to writing novels and get out of the propaganda field. He is merely acting as a tool for the militarists in the Pentagon who in essence have established a military dictatorship in the U.S. by exerting their influence in foreign policy, by propagating the cold war for their own selfish interests, by drafting American boys in time of peace, and by spending over $40 billion of the taxpayers' money every year.

These same people, under the direction of Gen. Norstad, are pushing the rearming of West Germany with atomic weapons under the guise of NATO. They have even enlisted outgoing Secretary of State Herter in this venture. They have also succeeded in elevating a former Nazi general, Adolf Heusinger, to chairman of the Permanent Military Committee of NATO. And now they want to directly run our lives by imposing civilian defense regulations over our very existence.

The biggest hoax that the military and people like Pat Frank have perpetrated on the American Public is their claim that there can be an atomic war in which mankind can survive. And yet they spend billions of our dollars for just such an eventuality.

The American Public should know that no amount of atomic shelters can save anyone in this country, or in fact anyone in the whole world. Even if only the existing atomic bombs, H-bombs, and Cobalt bombs held by both the East and West were exploded, radioactivity in its various forms such as Strontium 90 would permeate all existing plant life and in short order life in this world would be non-existent.

People like Pat Frank should be called short in their spreading of the big lie so that the world can start looking for the way to peace. What I am now wondering is who paid Mr. Frank to write this article?

John Savas
Canton, Ohio

CONGRATULATIONS and appreciation for the article on Civil Defense by Pat Frank. The writer particularly appreciates the mission that is suggested for the reserve forces.

A few reservists have pleaded for such a mission for years. The time is now on us when the thought of "mobilizing in the event of a National Emergency" is an obsolete concept. This is the foundation of the law which created the reserve forces after World War I. It served reasonably well for WW II, and less well for Korea. It is not adequate today.

Reserves are the ideal forces for the mission of protecting the internal security of the nation. They have had military training, they are familiar with weapons, they know supply and logistics, and they can take care of people in emergencies. Further, they are ideally dispersed so that no attack can possibly obliterate them.

Organize companies of Army Reserve combat troops served with three troop carrying aircraft of Air Force Reserve around every airport of the nation that can accept the aircraft, and you have a mobile army that can arrive at any point of trouble within two hours. A few men and rifles in the first post-attack hour can do far more than a thousand the next day.

It will be time to mobilize and go on to other missions after the enemy attack has been resisted, and there is time to count heads to see where the next bit of help is needed.

T. B. Holliday
Colonel, AFRe
Chicago

CONGRATULATIONS on the artic "Kennedy Should Put Civil Defense unde Military" (M/R, Dec. 12, p. 16) by P Frank. Mr. Frank very ably blasts at th complacency that exists in the United Stat about the dangers of atomic war. Th article should be reprinted on the fro page of every paper in the United State

More shelters and fewer swimmi pools are what we need.

David W. Johnston
Washington, D.C.





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# —when and where—

## JANUARY

**Seventh National Symposium on Reliability and Quality Control,** Bellevue-Stratford Hotel, Philadelphia, Jan. 9-11.

**International Congress and Exposition, Society of Automotive Engineers,** Cobo Hall, Detroit, Jan. 9-13.

**Symposium on Space Instrumentation, Institute of Radio Engineers, PGSET,** Washington, D.C., Jan. 16-17.

**American Astronautical Society, Annual Meeting,** Sheraton-Dallas Hotel, Dallas, Jan. 16-18.

**Winter Instrument-Automation Conference & Exhibit, Instrument Society of America,** Jefferson Hotel and Kiel Auditorium, St. Louis, Jan. 17-19.

**29th Annual Meeting, Institute of the Aeronautical Sciences,** Hotel Astor, New York City, (**Honors Night Dinner** Jan. 24), Jan. 23-25.

**1961 Plant Maintenance and Engineering Conference,** International Amphitheatre, Chicago, Jan. 23-26.

**American Mathematical Society, National Meeting,** Willard Hotel, Washington, D.C., Jan. 24-27.

**Society of Plastics Engineers, Annual Technical Meeting,** Shoreham and Sheraton Park Hotels, Washington, D.C., Jan. 24-27.

**American Institute of Electrical Engineers, Winter General Meeting,** New York City, Jan. 29-Feb. 3.

**American Society for Testing Materials, Committee Week,** Netherland Hilton Hotel, Cincinnati, Jan. 30-Feb. 2.

**American Physical Society,** New Yorker Hotel, New York City, Jan. 31-Feb. 4.

## FEBRUARY

**Institute of Radio Engineers, PGMIL,** Los Angeles, Feb. 1-3.

**American Rocket Society, Solid Propellant Rocket Conference,** The Hotel Utah, Salt Lake City, Feb. 1-3.

**Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting,** Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, Feb. 26-Mar. 1.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

**Western Joint Computer Conference,** Los Angeles, Feb. 28-Mar. 1.


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Aerospace Corp. ..... 19
Agency—Gaynor & Ducas, Inc.

Autonetics, a Div. of North American Aviation, Inc. .. 35
Agency—Batten, Barton, Durstine & Osborn, Inc.

Avco Corp. ..... 51
Agency—Benton & Bowles, Inc.

Avnet Electronics Corp. .... 22
Agency—Dale & Finkels, Inc.

Cannon Electric Co. ..... 8
Agency—Anderson-McConnell Adv. Agency, Inc.

Delco Radio, Div.-General Motors Corp. ..... 31
Agency—Campbell-Ewald Co.

Douglas Aircraft Co., Inc. .. 20
Agency—J. Walter Thompson Co.

C. P. Goerz American Optical Co. ..... 7
Agency—R. E. McGuire Assoc., Inc.

Haws Drinking Faucet Co. .. 48
Agency—Pacific Adv. Staff

Hoffman Electronics Corp., Semiconductor Div. ..... 52
Agency—Allen, Dorsey, & Hatfield, Inc.

Kearfott Co., Sub.-General Precision Equipment Corp. 41
Agency—Gaynor & Ducas, Inc.

Kollmorgen Corp. ..... 6
Agency—Wilson, Haight & Welch, Inc.

Mimx Corp. ..... 45
Agency—The Martin R Klitten Co., Inc.

Monsanto Chemical Co. ...2, 3, 4
Agency—Gardner Advertising Co.

Propellex Chemical Corp. ... 39
Agency—Al Maescher Adv.

Radio Corp. of America, Industrial Electronic Products 26, 27
Agency—Al Paul Lefton Co., Inc.

Reinforced Plastics, Dept. of Raybestos Manhattan, Inc. 46
Agency—Gray & Rogers, Adv.

System Development Corp. . 10
Agency—Fuller & Smith & Ross, Inc.

EMPLOYMENT

Amcel Propulsion Inc., a Sub. of Celanese Corp. of America ..... 49

# Military Dogma Fades Slowly, Too

IT IS DOUBTFUL if the proposed reorganization of the U.S. defense structure, during the next year at least, will be much more than the administrative changes which can be accomplished by executive action.

This will be a great disappointment to those who would like to see some of the layers of indecision and inaction swept out of the Pentagon corridors.

The important thing is that the plan presented to Mr. Kennedy to revamp the U.S. military establishes a goal. There is little conviction in the minds of even those who will oppose the Symington plan most bitterly, that our defense structure is the best it could be, or that its design permits it to cope with the military needs of the times.

It is axiomatic in military history that the defending forces in any major war fight with the same organization and the same tactics they employed at the conclusion of the last major war.

It is also historically axiomatic that these defending forces get the daylights kicked out of them until they modernize their organization and tactics.

The French began World War I with the same artillery barrages and cavalry charges which had conquered them at Sedan in 1870.

The allies began World War II with the trench warfare concept which had prevailed in 1919. (The Germans had mechanized and the French again lost their war at Sedan)

In those conflicts there was time for change, time to change from a peacetime military into a wartime military. The cost was high in lives and cities but after all, the world was accustomed to this. Men had been dying and cities falling to the rigid military mind since the first written lines of history.

But these are different days and different times, even though only 15 years and a few months have passed since Japan surrendered to the only two atomic weapons ever dropped in combat.

This is the day when atom-tipped missiles fly 5000 miles in thirty minutes, when bombers carry 20-megaton loads, when satellite launchings have become commonplace.

It is also the day when the United States has solid commitments to go to war in strange and remote places in defense of tenuous democracy, or at least to prevent the spread of communism by force.

DO WE REALLY have a mobile strike force with what components, land, sea and air are needed, ready to take off for Laos on hours' notice? Under one command and not three?

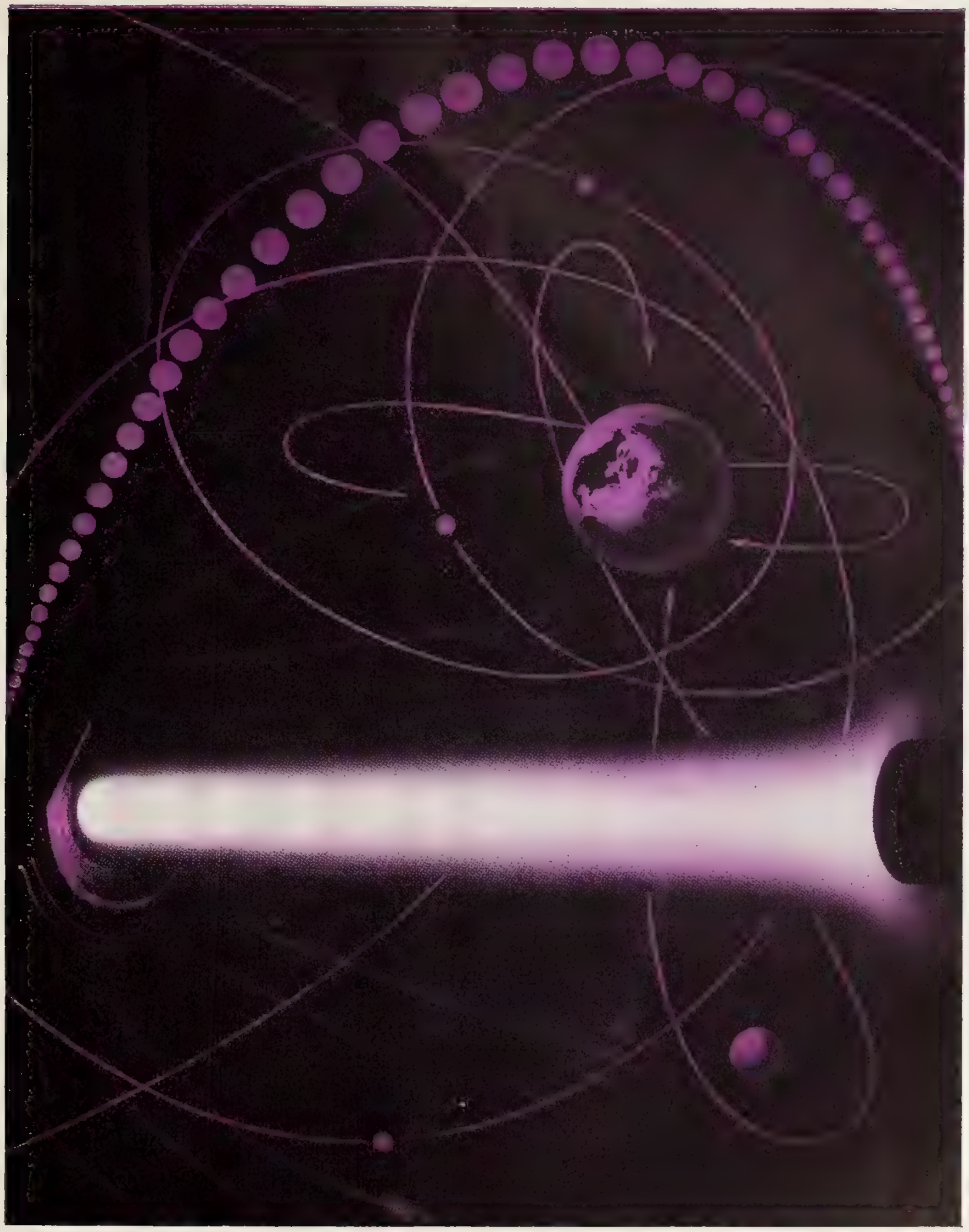
Are we strategically unified to provide the greatest possible retaliatory threat? Are we prepared to take the first blow and still fight back?

Probably not, in any instance. And it is doubtful if we shall be quickly. The rigidity of the military mind has its counterpart in the civilian, particularly if the civilian happens to wear four stars in Congress.

So, the change will come slowly. The Symington plan may not be the best and it may not be acceptable to those with the power to disapprove modernization. It does, however, provide a goal and this—again—is perhaps most important.

The new team which moves into the Administration and the Pentagon can do a great deal by executive order and clear-cut decision if the team is so determined.

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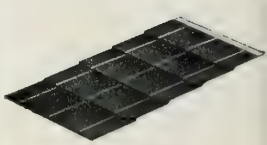
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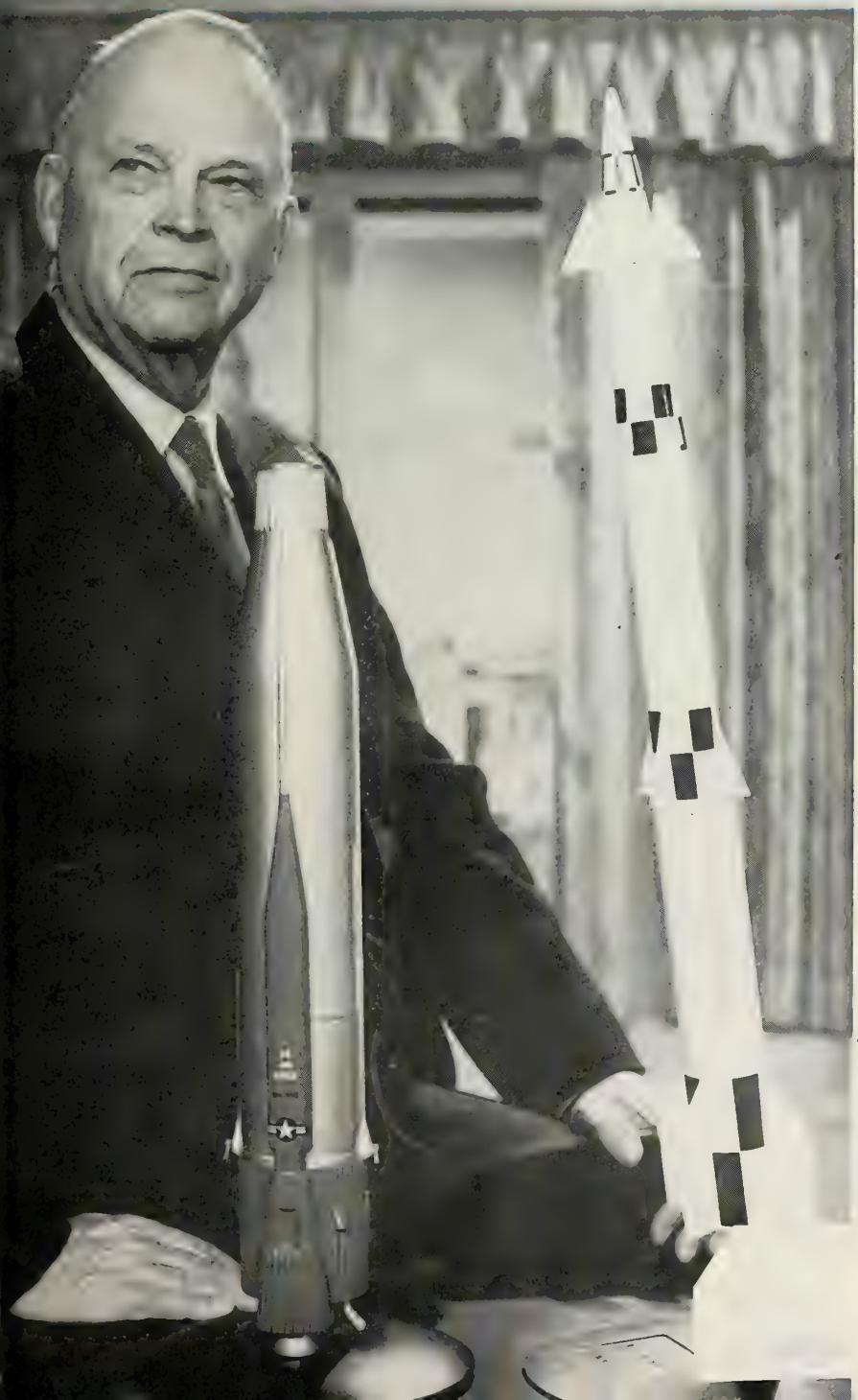
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# missiles and rockets

THE MISSILE/SPACE WEEKLY



## JFK Pushes U.S. Space Shake-up

- P-14 to Map Radiation
- A Major New Drive Concept
- Reds Bid for Lead in Math

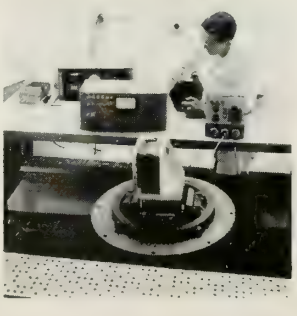
*Senator Kerr: 'Now we've got the ball.'*

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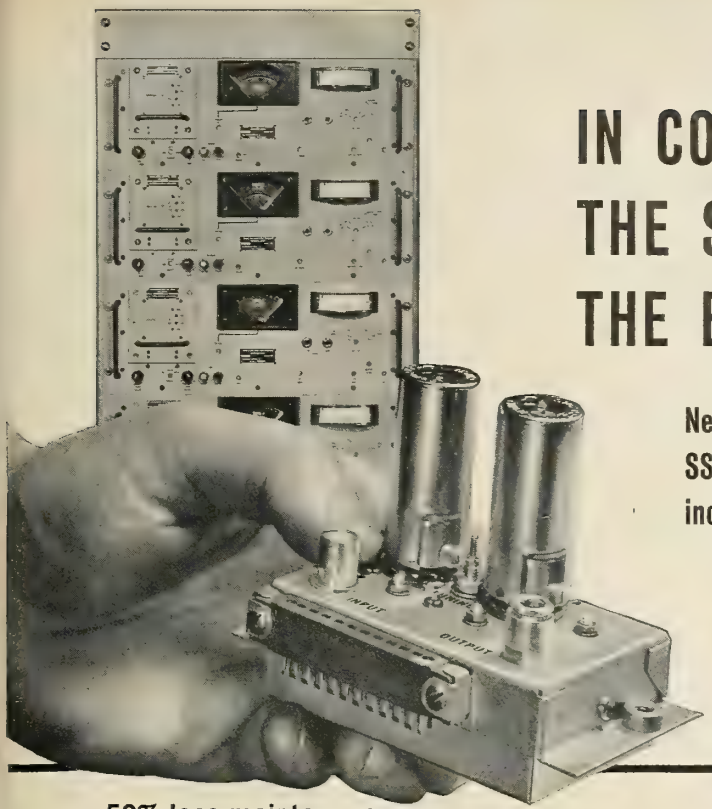
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It is extremely stable—1 part in $10^6$ per month (standard) or 1 part in $10^8$ per month (special) . . . it permits, for the first time, continuous, unattended operation with *maximum reliability.*

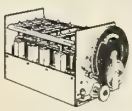
The SX-116 weighs in at just 36 lbs.—equally practical for fixed, mobile, air or seaborne installations. *And its initial cost is very substantially lower.*

Finding a better and simpler solution to complex communications problems has been a Hallicrafters habit for over a quarter-century.

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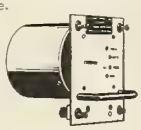
Military Electronics Division, Chicago 24, Illinois

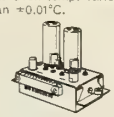
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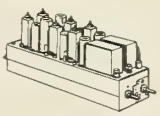
**HF Crystal Oscillator Module.** Stability: 1 in $10^6$ per month. Capacity is four crystals; designed for HC-6/U metal or glass crystal holders. Oven temp. varies less than ±0.01°C.





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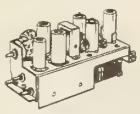
**IF Module.** Allows simultaneous reception of upper and lower sideband, independent AGC control of upper and lower sideband.

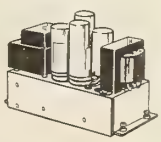




**BFO Module.** Operates at 1650.000 kc. Oscillator frequency stabilized in separate oven. Plate and filament voltages regulated.

**Audio Amplifier Module.** Features duel, independent 100-milliwatt line amplifiers. Hum level is 80 db. below 100 milliwatts. Harmonic dist. less than 0.5%.





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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 3 January 16, 1961

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## THE COVER

*Sen. Robert S. Kerr (D-Okla.), newly named chairman of the Senate Space Committee, is a key figure in President-elect Kennedy's plans to intensify space effort. See p. 11.*

## JANUARY 16 HEADLINES

Kennedy Administration Maps 90-Day Space Shake-up 11
NASA Balks at Switch from Atlas to Titan Booster ... 13
NASA's P-14 to be Major Probe of Space Radiation .. 13
More Blue Scout Launchings Scheduled Shortly ..... 16
Navy Takes Over Langley Hydrodynamic Facilities .. 32
AEC Moves to Cure Los Alamos Housing Shortage .. 32
Army Shows Prototype of New Antitank Missile .... 34

## BASIC RESEARCH

RIAS Report Warns Soviet May Take Lead in Math .. 20

## ENGINEERING

Harmonic Drive Concept Should Enhance Missilery .. 22

## SUPPORT EQUIPMENT

Report on NASA's $70-Million Construction Boom ... 25

## ELECTRONICS

Land-Air's Complex Tracking Job at White Sands .... 28
Minuteman Equipment Is Highly Integrated ..... 35

## INTERNATIONAL

Oerlikon's Adaptable Aircraft Missile System ..... 30

## R&D FACILITIES

Army Readies Huge Test Building at Huntsville .... 39

## PROPULSION ENGINEERING†

Picture Report on Latest Testing of Tory Reactor .... 40

## DEPARTMENTS

The Missile/Space Week† ..... 6
The Countdown ..... 9
Industry ..... 17
Technical Countdown . 19
Soviet Affairs ..... 32
Editorial ..... 50
Names in the News .. 42
Contracts ..... 43
Products & Processes . 44
Letters ..... 48
When and Where ... 49
Reviews ..... 49

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### 2nd Hard Minuteman Base

The Air Force has designated Ellsworth AFB, Rapid City, S.D. the nation's second hardened *Minuteman* base and is considering putting a third at Pease AFB, Portsmouth, New Hampshire.

Like the first hardened base at Malmstrom AFB, Montana, the base will provide support for a wing, consisting of three squadrons. Air Force plans call for 150 missiles in the three squadrons. The number of units in the mobile *Minuteman* wing headquartered at Hill AFB, Utah, has not been disclosed.

Soil borings are being made at Pease to determine whether there are enough good sites for underground facilities, but it will take several months to select locations, the Air Force said.



**Dyna-Soar Mated to B-52**

*B-52H BOMBER at Boeing's Wichita, Kan. plant carries for first time test models of Douglas Skybolt ALBM. Compatibility tests were begun this last week.*

### Polaris: One Up, One Down

The Navy scored a big advance and a small set back this last week in two Lockheed *Polaris* launchings at Cape Canaveral.

An A2 R&D *Polaris*—the *Polaris II*—ripped from a surface pad and roared 1600 statute miles down the Atlantic Missile Range. It impacted only 125 miles short of the eventual range of the operational *Polaris II*.

The 31-ft. *Polaris II* is three feet longer than the operational *Polaris I* already deployed aboard two nuclear-powered submarines. Range of *Polaris I* is nearly 1400 statute miles.

The Robert E. Lee—third sub of the *Polaris* fleet—resumed its submerged test launchings of *Polaris I's* off the Cape a day after the successful A2 shot.

The *Polaris*, launched from about 60 feet beneath the surface of the Atlantic, broke the water and appeared to be on its way when a malfunction developed in the first stage. The range safety officer destroyed the missile.

The Robert E. Lee successfully launched a *Polaris* while submerged last December. It is expected to attempt to launch one more before going on station.

### Strike Help Coming

Hearings will begin shortly on costly wildcat strikes which have caused severe slippage in the *Atlas* and *Titan* base programs.

The Senate investigations committee, headed by Chairman John L. McClellan (D-Ark.), has "authorized




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a full-scale investigation" into work stoppages at Cape Canaveral and other major missile bases.

Sen. McClellan said preliminary inquiries indicate a possible serious blow to the position of the United States and a waste of millions of dollars.

## NORAD Seeks Shelter

The Defense Department is pushing to move the nation's Air Defense Command headquarters underground to safeguard it from enemy missile attack.

Defense Secretary Thomas S. Gates has asked the appropriations committees of the House and Senate to free $8.5 million already earmarked for the project. It would go to excavate Cheyenne Mountain near Colorado Springs, for new NORAD headquarters.

Some $1.5 million has already gone to building a road and surveying the area. Congress originally had appropriated $10 million for the project, but the Joint Chiefs of Staff had recommended abandoning it at one time.

Additional funds will be needed for equipment.

## Cannon Sees SAC Demise

Rep. Clarence Cannon (D-Mo.), chairman of the powerful House Appropriations Committee, contended this last week that the time for the Strategic Air Command as America's chief deterrent force is "running out."

He told the House: "Only the nuclear-powered missile-firing submarine can take over the task of the Strategic Air Command when obsolescence overtakes it in the inevitable development of Russian technology."

## Dyna-Soar Progresses

Eleven companies attended a Boeing Airplane Co. bidder's conference on requirements for the *Dyna-Soar* test-instrumentation subsystem. Boeing will award the subcontract sometime in the early spring.

Minneapolis-Honeywell has emerged winner of a subcontract totaling more than $2 million for *Dyna-Soar* flight control electronics design, development and production. Flight tests on the space glider are expected to begin in 1963.





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## Said Isaac Newton:

*"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."*

Until recently, the thrust which propelled rocket vehicles into their coast phase, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

These principles have made possible the early development of the MIDAS satellite. Moreover, they substantially increase the altitude and payload of the DISCOVERER and SAMOS satellites. Lockheed, Systems Manager for these programs and for the POLARIS FBM, is pursuing even more advanced research and development projects. As a result, there are ever-widening opportunities for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-15F, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

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# The Countdown

## WASHINGTON

### Gap in the Space Council

Military men are looking rather questioningly at plans to beef up President-elect Kennedy's National Space Council. The group, as presently constituted, is entirely civilian. Presumably it will remain that way. What the military men are wondering: How can the Council act as a really effective advisory body if the services are not represented other than by the (civilian) Secretary of Defense? Will this lead to a "gap" in the pursuit of strategic space systems?

### Watch the Russians

Speculation that the Soviets will carry through with a rumored Inauguration Day space spectacular is being heightened by the deployment of three Russian missile tracking ships in the Pacific. They appear to be headed for the same area about 1000 miles southwest of Hawaii where previous Soviet missiles have impacted. Manned orbital shot is expected to be next on the Kremlin calendar.

### Slipped Chimp

That *Mercury-Redstone* chimp shot tentatively set for a few days before Kennedy's inauguration has now slipped to the week of Jan. 22. There also is more delay in the *Mercury-Atlas* series while NASA attempts to fix a problem in capsule mating which apparently has caused two failures. (see p. 13).

### Kennedy Must: Big Boosters

Look for a major push by the Kennedy Administration to develop big booster rockets. More money may be placed down the line on *Saturn*, the *F-1*, *Titan II* and *Atlas G* as well as nuclear engine development, like the atomic pulse *Orion*. The big problem facing the new administration is to obtain a large payload capability as soon as possible.

### Space on the Hill

Hearings before both the Senate and House Space Committees are expected to begin quickly as soon as President-elect Kennedy takes office. Both groups will conduct broad reviews of the U.S. space program to date and where space experts think it should be headed. However, first order of business before the Senate Committee will unquestionably be confirmation of the appointment of the new NASA Administrator.

### NASA vs. Pentagon

One of the hottest topics at the forthcoming hearings is certain to be the future roles of the Pentagon and NASA in space. A number of key congressmen such as Chairman Brooks of the House Space Committee want to see both roles expanded. However, others question that it is possible to expand both significantly without gross duplication.

### Dr. York on the New Frontier

Intra-Pentagon strategists consider that one of the more interesting and possibly somewhat depressing deployments on the New Frontier is the retention at least temporarily, of Herbert York as Pentagon R&D Director. Many proposals already stopped at York's desk were being refurbished for presentation to his expected successor. Now they are being put back in the files for a more propitious day.

### Wanted: Fast Decisions

Sources close to the new Defense Department top command say that one of the early innovations will be a drive for fast decision-making. The question being asked is how decisions can ever be made faster as long as the number of decision-makers keeps increasing. Faster decision-makers, maybe?

## INDUSTRY

### Nike-H Production Line Ends

Western Electric has delivered the last *Nike-Hercules* system on its production line to the Army. However, production of radar conversion kits for the *Advanced Nike-Hercules* is continuing. As system production ended, the Army began deploying another 100 sets of *Nike-Hercules* equipment and more than 50 *Nike-Ajax* sets overseas.

### Protecting Contractors

Once again DOD is asking Congress to permit indemnification of contractors against unusual hazards encountered in production and construction projects. Legislation is now considered mandatory as more missile programs move into production phase. Coverage would be similar to that now in force under R&D contracts.

### Eagle Flight Test Year Away

Latest progress report in the Navy's Super-secret and radically new *Eagle* air-to-air missile puts the first flight test about one year from now. Question of what plane it will be used on is still up in the air—if a plan to stop development of the specially configured Missileer goes through.

### Front Office

Both Washington State senators contend the FY '62 Eisenhower budget has $1.2 billion in it earmarked for military projects involving Boeing Airplane Co. . . . Martin Co. stockholders have okayed a 2-for-1 stock split . . . B-70's revival is creating a recruiting stir.

## INTERNATIONAL

### Nod for T-Bird

Word is out that the British defense Ministry has given the Army's *Thunderbird* air defense missile a production go-ahead over the RAF's *Bloodhound*. Reason: the *T-bird* (made by English Electric) has greater mobility.

### Deaf Ear to Talking Satellites

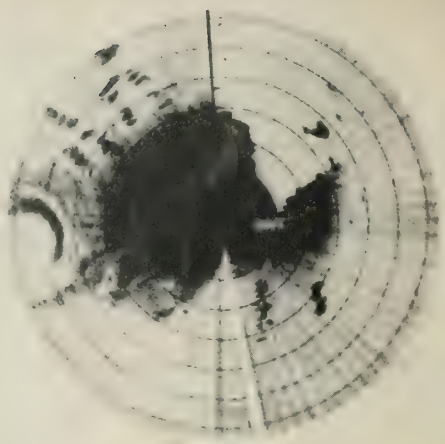
The British appear to be taking a go-slow attitude to dropping any of their pounds in developing a communications satellite. Maj. Gen. L. de M. Thuiller, leader of a recent fact-finding team that discussed communications satellites proposals in the United States, is understood to have reported to his government that commercial communications satellites appear to him to be 15 to 20 years away. Interest is reported to have cooled considerably.

### Joint Rocket Production

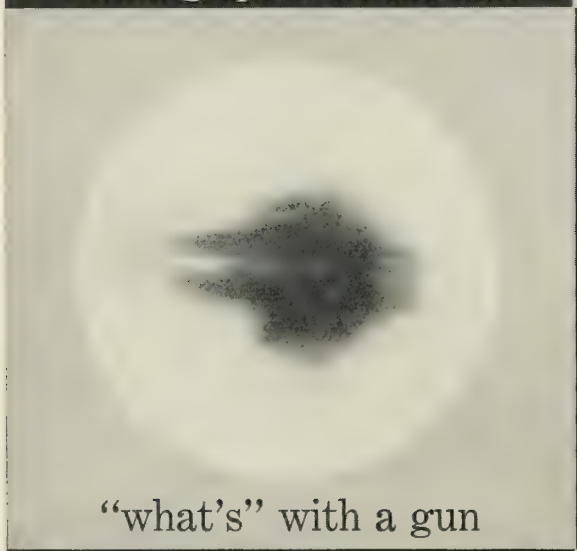
Stages for the British *Jaguar* three-stage rocket are being produced at opposite ends of the earth. RAE, Farnborough, is turning out the first stage of the 40-foot rocket. The Australian Department of Supply is turning out the second and third.



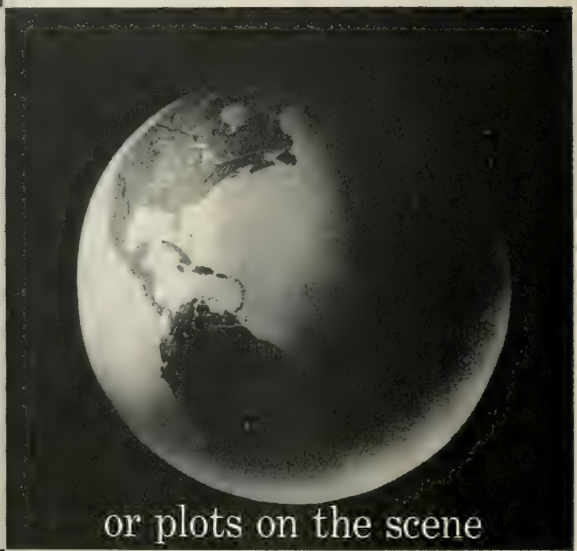
Filming spots on the sun



or dots on the screen



"what's" with a gun



or plots on the scene

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# Space Shake-up Coming

## *DOD-NASA programs being revamped*

**by James Baar**

A SWEEPING SHAKE-UP of U.S. space programs—both military and civilian—and the organizations directing them is now expected within 90 days after the Kennedy Administration takes office Jan. 20.

The shake-up will be aimed at meeting the Soviet challenge in space to America's military security and world position.

The changes will be guided and monitored by the revived National Space Council under the chairmanship of Vice President-elect Lyndon B. Johnson.

The direction that the new Administration is planning to take was outlined to a considerable extent this last week in the "preliminary" space report by an Ad Hoc Committee to President-elect Kennedy. (See below.)

Kennedy, Johnson and some of their key advisers were understood to have been favorably impressed with the committee's recommendations, which included calling for the redefining of U.S. space program objectives—and possibly a single military space command.

Sen. Robert S. Kerr (D-Okla.), newly named chairman of the Senate Space Committee, called the space report "very constructive." He predicted that a "vigorous" overall space program would be developed by the Administration "to set the pace we need to set and then maintain it."

Rep. Overton Brooks (D-La.), chairman of the House Space Committee, called the report "an encouraging document that points the way to a more progressive and advanced space program."

Both congressional committees will play a major role in a general review of current U.S. space efforts recommended by the space report. However, a number of developments indicated that the Administration will use the Senate Committee as its main sounding board and investigative arm for determining where to place its space bets.

• **Money matters later**—The nine-member Ad Hoc Committee—headed by Jerome B. Wiesner, director of MIT's Electronics Research Lab—touched only lightly on the delicate subject of money. The reason appears to be the logical idea that it is difficult to put a price tag on a program until its contents have been determined.

Kerr, who was with Kennedy and Johnson when the committee made its report, expressed this attitude later.

"You can't buy a space program," he said in an interview. "No mercantile establishment on earth carries one as its stock in trade. You have to develop a space program. Once you have done that, it is a lot easier to get the money to pay for it."

Kerr said that he would not know whether more money beyond current spending would be needed until current programs are reviewed. He indicated, as have others in the new administration, that present spending on space programs—which is nearing $2 billion a year—might go much farther if spent differently.

However, when asked what he would think of a proposal to double U.S. spending on space, Kerr said: "I would be neither shocked nor mesmerized. If our analysis showed that we needed to spend that much for the security of the country, I would favor it."

Brooks said he favors increasing the FY '62 budget for NASA alone to at least $1.5 billion.

## Highlights of Space Report

### *FINDINGS*

• Our review of the United States' space program has disclosed a number of organizational and management deficiencies as well as problems of staffing and direction which should receive prompt attention from the new Administration. These include serious problems within NASA, within the military establishment, and at the executive and other policy-making levels of government.

• Neither NASA as presently operated nor the fractionated military space program nor the long dormant Space Council have been adequate to meet the challenge that the Soviet thrust into space has posed to our military security and to our position of leadership in the world.

• The nation's ballistic missile program is lagging. The development of the missiles and of the associated control systems, the base construction and missile procurement must all be accelerated if we are to have the secure missile deterrent force soon that the country has been led to expect.

• Because of our lag in the development of large boosters, it is very unlikely that we shall be first in placing a man into orbit around the earth. . . . The ultimate goal of this kind of endeavor would of course be an actual landing of man on the moon or a planet. It is not possible to accomplish such a mission with any vehicles that are presently under development.

• . . . The rapid development of boosters with a greater weight-lifting capacity is a matter of national urgency. . . . The present *Mercury* program, based on the *Atlas,* is marginal.

### *RECOMMENDATIONS*

• Make the Space Council an effective agency for managing the national space program.

• Establish a single responsibility with the military establishments for managing the military portion of the space program.

• Provide a vigorous, imaginative, and technically competent top management for NASA, including:

(a) Administrator and deputy administrator.

(b) A technical director for propulsion and vehicles; a technical director for the scientific program; a technical director for the non-military space applications; a technical director for aerodynamic and aircraft programs.

• Review the national space program and redefine the objectives in view of the experience gained during the past two years. Particular attention should be given the booster program, manned space flight, the military uses of space, and the application of space technology of the civilian activities of the country.

• Establish the organizational machinery within the government to administer an industry-government civilian space program.

The present NASA budget is slightly over $900 million, and the Eisenhower budget for NASA for FY '62 provides only moderate increases. Military spending for space programs currently is running under $1 billion.

• **Hard on NASA**—The Ad Hoc Committee concentrated primarily on U.S. space goals and organization. In both cases, it implied almost as it said outright.

It repeatedly urged that U.S. space goals be reassessed thoroughly and promptly—"particularly in regard to man-in-space, space, science and exploration, and non-military applications of space in order to have a proper division of effort."

The obvious implication was that the committee felt that present goals are poor ones and that the present division of effort between the Pentagon and NASA should be readjusted. What the readjustment should be was not made clear.

However, the report repeatedly criticized NASA operations. It said among other things that NASA's main program, *Mercury* was marginal; that NASA "channeled into NASA-operated facilities . . . too large a fraction" of its program; that it gave "little attention" to aeronautics R&D, which perhaps should go to another agency.

Finally, the report clearly implied in its recommendations that NASA lacked "vigorous, imaginative and technically competent top management."

• **Accent on positive**—The committee laid particular stress on the scientific and commercial gains to be expected from space programs.

"The government through NASA or the Department of Defense should make available the required physical facilities as well as any extraordinary financial support required to make the undertakings successful," it said. "Organizational machinery is needed with the Executive Branch of the Government to carry out this kind of civilian space program."

But of all of the committee's recommendations and criticisms possibly one of the most cutting was reserved for scientific participation in U.S. space programs. The committee said:

"In addition to the difficulties and delays which the program has endured because of the lack of sufficient planning and direction, it has also been handicapped because too few of the country's outstanding scientists and engineers have been deeply committed to the development and research programs in the space field."

The committee besides Wiesner included: Physics Prof. Edward Purcell of Harvard; Chemistry Prof. Donald Hornig of Princeton; Physics Prof. Bruno B. Rossi of MIT; Edwin H. Land, president of Polaroid; Trevor Gardner, president of Hycon Manufacturing Co. and former assistant Air Force Secretary for R&D; Kenneth E. BeLieu, staff director of the Senate Space Committee; Max Lehrer, the committee's assistant staff director; and Harry J. Waters assistant to the President of Polaroid.

• **Kerr sums up**—Much of the heart of what the committee said in its report was brought into improved focus by comments made by Kerr after he was officially named chairman of the Space Committee to succeed Johnson.

The sharp-witted Oklahoma senator leaned back in his desk chair and said:

"We've said some pretty strong things about the Administration's space program. Now we've got the ball. We must move vigorously and actively to analyze and appraise and improve the space program or put ourselves in the position of acquiescing."

Kerr smiled.

"Today the space program is mainly the program of the Eisenhower Administration," he said. "We have a limited time to demonstrate our purpose and ability to improve it and develop a program of our own. We intend to do it."

Then the new chairman offered an insight into his view of where the United States would go in space. He said:

—"First we will explore the space immediately adjacent to the earth including the moon, Mars, Venus and Mercury."

—"Second we will have a period of preliminary economic development in this area including operating a vast system of long-distance communications, a vast system of weather forecasting, and rocket transportation facilities."

—"Third we will advance our explorations to the rest of the solar system, including Pluto, Neptune, Uranus, Saturn and Jupiter."

Kerr paused pointedly; then added:

"We're no more prepared to forecast accurately the full significance of these developments and extent of their effect on society than Christopher Columbus would have been able to forecast accurately the development of western civilization following his arrival at San Salvador." ⌗

## *Keen Mind for Space Problems . . .*

*ROBERT S. KERR, who was born in a log cabin, grew up to become an oil millionaire and finally moved to a Senate seat in 1949, takes over the chairmanship of the Senate Space Committee at a critical time in the East-West space race.*

*In fact, some observers contend this may well be the last critical time: The United States must surge ahead now or never.*



*Kerr typically makes no claim to space expertise. But the big, 64-year-old Oklahoma senator has one of the sharpest and quickest minds in Congress. And, with some rapid but solid briefing, he has been known to become an impressive and incisive expert on many abstruse matters on very short order.*

*Moreover, in whatever he undertakes, Kerr is a dogged and enthusiastic fighter as well as a master needler. It is in the latter art that he is most feared by his colleagues, who generally shy from verbal battle with him on the Senate floor.*

*Kerr faces the world with vast and much justifiable self-confidence. Characteristically, when he lost the Democratic presidential nomination in 1952, he said: "It would appear that the people do not realize what a superior product was being offered them."*

*For 12 years Kerr (as a member of the Public Works Committee) has championed conservation measures and (as a member of the Finance Committee) has interested himself in tax and social security problems. His campaign slogan has been: "Land, Wood and Water."*

*Now he's added two words. The Slogan is: "Land, Wood and Water—and Space."*

*Sticking with Atlas . . .*

# Mercury Men Balk at Switch to Titan

***Booster change would only cause more slippage, NASA claims; 'fix' expected to correct source of recent Atlas explosions***

OFFICIALS OF THE SLIPPING *Mercury* man-in-space program are strongly resisting a suggestion to the Kennedy Administration that they consider switching to a *Titan* booster because of the "marginal" reliability of *Atlases*.

They feel a changeover in boosters at this point would only mean more slippage.

Moreover, they believe the technical troubles which have caused failures in four *Atlas*-based lunar orbit vehicles and two *Mercury* shots have been located and can be corrected. NASA plans to launch 35 *Atlas*-based vehicles in the next three years.

The reaction from NASA was swift and to the point following the submission of a report on the nation's lagging space program to President-elect Kennedy (see pages 11 and 12) last week. The report by an Ad Hoc Committee said:

"The present *Mercury* program, based on the *Atlas,* is marginal and if the *Atlas* proves inadequate for the job it may be necessary to push alternatives vigorously. The first possibility appears to be the *Titan,* although it has not demonstrated the reliability which is required. We should study the desirability of carrying out a *Titan*-boosted *Mercury* program in the event *Atlas* should prove to be inadequate."

No time limits on the "adequacy" of *Atlas* were set forth in the report.

However, *Mercury* Chief Robert R. Gilruth indicated that he saw no need to even entertain the idea of switching to *Titan. Atlas* was chosen more than two years ago because it was ahead of *Titan* in development, Gilruth said, and "it is still ahead."

• **Mating problem**—Even if *Titan* were ready in a stage to use as a *Mercury* booster, the problem of mating the capsule would still exist and cause further delay. Just how much, Gilruth did not say.

It is in this area that the troubles have cropped up with *Atlas*. The problem seems to be at the upper end of the booster or in the capsule adapter ring. It is one apparently involving structural strength, bending moment and harmonic effects. If so, *Mercury* officials feel it will be comparatively easy to fix.

A partial fix will be attempted in *Mercury Atlas II* (MA-2) scheduled to be launched before the end of March. A complete fix, ordered as a result of the explosion of an *Atlas-Able* lunar orbit vehicle last month after 70 seconds of powered flight, will be tried with MA-3. As a result, MA-3 will slip into the second quarter of this year. It had been scheduled to go in the first quarter.

Gilruth also feels *Atlas* will be more reliable with a man aboard because all three of its main engines are ignited on the ground, where *Titan* involves a second-stage ignition in flight.

Cause of the failure of the escape system in the *Little Joe 5* test on Nov. 8 has been established as a malfunctioning limit switch, Gilruth reported. "The Navy recovered the guilty part."

The wiring and physical hookup were changed in time for the successful *Mercury Redstone I* shot last month. However, another *Little Joe* is being prepared for launching. This experiment, as well as the second *Mercury Redstone* (MA-2), which will carry a chimpanzee, must both be successful before a man is launched in a *Mercury* capsule.

• **List of 'musts'**—As for the *Atlas* tests, NASA's Space Task Group last week outlined a series of experiments that must succeed before the manned orbital shot. Assuming each experiment works the series might go as follows:

MA-2—repeat of MA-1 with several additional systems in the capsule.

MA-3—another ballistic shot with the entire life support system and a "mechanical man."

MA-4—a capsule containing a chimpanzee, either on a ballistic trajectory or in orbit. (Gilruth said there must be an experiment in which a capsule is inserted into an orbital trajectory and then the retrorockets are fired immediately to bring it back. Presumably this might be done with MA-4.)

MA-5—chimpanzee in orbit.

MA-6—man in orbit.

Gilruth said that if all experiments succeed, manned orbital flight is still possible in calendar 1961.

However, he emphasized that in a research development program firm schedules cannot be set and each step depends on the success of the previous steps. If any experiments fail, it must be repeated.

Asked about a House Space Committee report that estimated *Mercury* might cost as much as $500 million, compared with current official estimates of $393 million, Gilruth said it is entirely possible that it will prove desirable to make more manned flights than are currently programed. Under present plans, the Project *Apollo,* 3-man spacecraft is not due to begin manned flights until 1968.

Gilruth was asked whether work on *Apollo* could not move faster. He said he is not qualified to answer that question.

• **Busy astronaut**—Dr. Robert B. Voas, STG psychologist, declared that the astronaut will have seven major duties during the *Mercury* flight. They will be to monitor the sequence of flight events, manage and monitor on-board systems such as power, oxygen and communications, operate attitude control, navigation, communications, research and evaluation activities, and keep himself in condition to meet coming environmental stresses.

Research and evaluation activities, Voas said, include:

–Observation of capsule function, such as cues not automatically followed and investigation of non-programed situations.

–Scientific observations of earth and space.

–Measurement of his own performance, such as inability to perform assigned functions and the effects of weightlessness on his sensing and controlling abilities.

–Reporting his medical symptoms.

Dr. T. Keith Glennan, retiring NASA administrator, praised the degree of cooperation between NASA and military departments.

"People in both NASA and the Department of Defense are ambitious and imaginative," he declared. "In such a situation there will always be pulling and hauling. But there has been less controversy and more cooperation in the last year than anyone had any right to expect."

# Major New Radiation Probe Readied

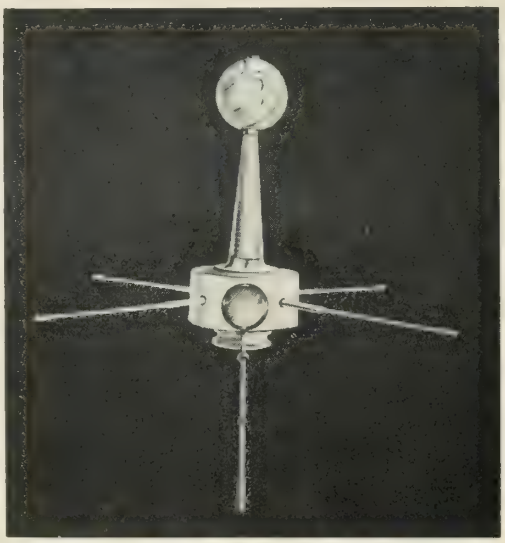
## *First details of NASA's P-14 payload designed to map magnetic fields in cislunar space with new rubidium-vapor magnetometer*

**by Charles D. LaFond and Jay Holmes**

THE UNITED STATES soon will make its first major attempt to map the magnetic fields in cislunar space, an essential step toward preparing the way for manned flight to the moon.

March is the target month for launching a *P-14* probe with a new and extremely sensitive rubidium-vapor magnetometer as part of its payload. Developed by Varian Associates, Palo Alto, Calif., and NASA's Goddard Space Flight Center, the system employs optical pumping techniques to measure radiation intensity.

A *Delta* vehicle will boost the 75-lb. spacecraft in an attempt to reach an altitude of 140,000 miles—more than half the distance to the moon. The probe will then plunge back and burn up in the earth's atmosphere.



*P-14 SPACE PROBE, due to be launched about March, is shown in this conception by a NASA artist.*

Magnetic-field charting is essential to manned space flight. The hazardous charged particles in solar flares and the Van Allen radiation belts follow paths that curve according to magnetic fields, of which exact knowledge will make possible the prediction of both danger areas and relatively safe paths.

• **Highly sensitive**—U.S. scientists apparently are far ahead of Russia in developing sensitive magnetometers, although Russia's *Lunik II,* by virtue of being the first spacecraft to land on the moon, provided the first report—a negative one—on the lunar magnetic field.

Russian scientists said their instruments, sensitive down to a level of 60 to 100 gammas, detected nothing. However, American and other scientists had predicted beforehand that a lunar field of more than 50 gammas would be unlikely.

The new magnetometer will be sensitive down to 0.1 gamma and perhaps .01 gamma. Besides *P-14,* it will be aboard *Rangers I* and *II,* the prototype lunar rough-landing spacecraft to be tested on *Atlas-Agena B* flights scheduled for the last half of 1961.

The present state of knowledge about magnetic fields in space beyond the earth's field is largely based on measurements from *Pioneer V,* the U.S. space probe that transmitted from as far as 22½ million miles away last year. *Lunik I,* the first Soviet interplanetary probe launched Jan. 2, 1959, carried a magnetometer but it was sensitive only down to 100 or 200 gammas, according to Dr. James P. Heppner of the Goddard Center.

*Pioneer V* data indicated an interplanetary field of about 2 gammas, Heppner continued. This surprised researchers and will require a reworking of current ideas about the way clouds of protons and other particles travel outward from the sun, both in quiet periods and during solar flares.

• **New techniques used**—The optical pumping principle, basis of Varian's rubidium-vapor magnetometer, is related to those underlying the maser and the atomic clock.

The single outer electron of alkali metals such as rubidium, is easily excited to any one of a number of higher-energy levels by action of light. After a tiny fraction of a second, the electron falls back to the lower level.

But in even a very weak magnetic field, electrons line up with their spin axes pointing along the direction of the field. Two electrons can be aligned parallel, both spinning in the same direction, or antiparallel, spinning in opposite directions. When an electron flips over and spins in the opposite direction, it gains a tiny amount of energy, much smaller than the amount involved when it is raised to a new energy level.

This tiny amount of energy is equal to the energy in the spin a photon of light gives up when it hits an atomic particle and excites it. But when an excited electron falls back to a lower level, it sometimes drops to a level representing the increased spin energy that includes the photon spin.

At such a level, the electron cannot be excited to a higher state by the action of light. In the physicist's language, such a transition would be forbidden. Thus, electrons in the maximum energy state tend to remain there, just as water tends to remain in a pitcher when it is lifted into the pitcher by a pump.

Gradually, the action of light would pump energies higher and higher until all electrons were in the upper state if it were not for the fact that collisions with each other and with the container wall knock them down again, faster than the pumping.

• **Frequency Flip**—However, A. Kastler and J. Brossel of the Ecole Normale Superieure in Paris discovered in 1955 that some gases introduced into the alkali metal vapor as impurities have the effect of slowing the energy loss, allowing the pumping to proceed. The impurity atoms, acting as buffers, have different shapes and electron orbits, which results in their having less tendency to flip the electrons over.

H. G. Dehmelt of the University of

Washington discovered that hydrocarbons with long straight-chain molecules act as the best buffers, after which Arnold Bloom and W. E. Bell of Varian developed their magnetometer based on the use of optical pumping.

When electrons in a chamber of rubidium-vapor are pumped up completely, the chamber is perfectly transparent to circularly polarized light of a frequency characteristic of rubidium. In the normal, random state of the electrons, some of the light is absorbed.

The magnetometer is based on the fact that a specific low radio frequency, depending on the strength of the magnetic field, is required to flip the electrons over and undo the pumping. At that frequency, the amount of light absorbed suddenly increases. Thus, essentially, the new Varian instrument is an extremely high-resolution spectrograph. One used in a recent *Javelin* test was comprised of a 140-mc, r-f excited, rubidium lamp; optics—consisting of a rubidium filter, lens, and a circular polarizer; Rb gas cell; lens and mosaic light sensor; amplifier and transmitter; plus a 90° phase-shift feedback circuit connected to a coil around the gas cell. The system required 5 watts input.

In the *P-14* instrument configuration, two sets of gas cells, optics and amplifiers are used with feedback coils driven from alternate amplifiers to obtain the phase shift. This minimizes associated electronics and results in a lower power, more flexible, broader band system.

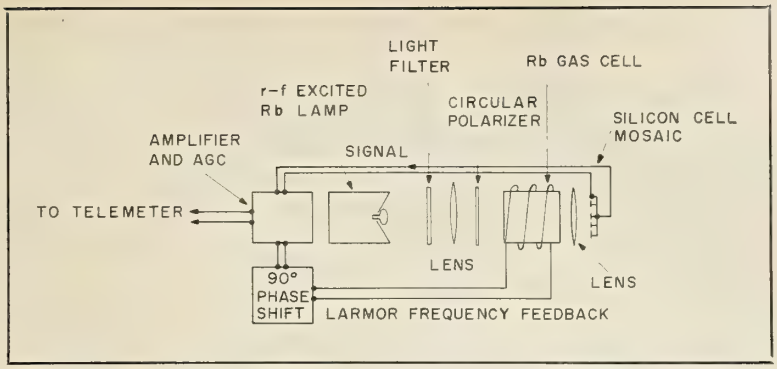
The output frequency from the magnetometer is proportional to the strength of the magnetic field environment. For *P-14,* an absolute vector magnetometer was developed by introducing a bias field commutated for six vectors.

• **60-hour output**—Additional equipment needed in the magnetometer package will include a 6-watt transmitter, four dipole antennas, an optical-aspect system, and battery pack.

The binary-output optical aspect consists of a slotted window which will feed data to a small digital computer for attitude reference. The computer provides a digital orientation reference for telemetering. This is necessary to interpret the field measurements more accurately since the payload will be spin stabilized.

An 18-watt battery pack housed in the center of the payload will provide up to 60 hours continuous effective output. The 35-lb. cylindrical pack consists of 168 Yardney silver-zinc primary cells.

The magnetometer in the *P-14* spacecraft will require only about 3 to 3.5 watts. A magnetometer based on the proton-precession principle, such as that aboard *Vanguard III,* would require much more power to obtain equivalent sensitivity, Heppner remarked.

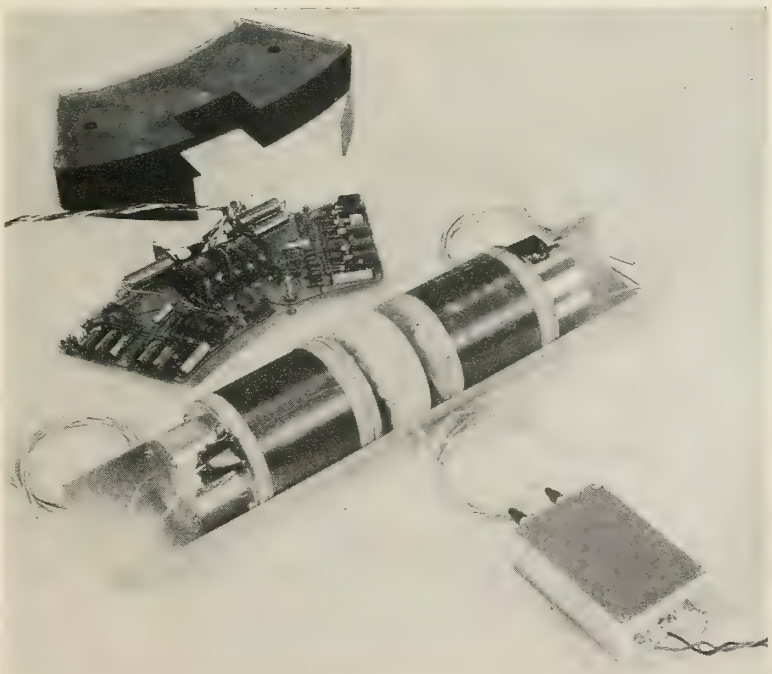



*RUBIDIUM-VAPOR self-oscillating magnetometer block diagram shows configuration used in the recent Javelin rocket test series launched from Wallops Island, Va.*

Proton precession magnetometers are inherently more accurate than those based on optical pumping, but they have a low sample rate. The weakest magnetic field measured by *Vanguard III* was 7000 gammas, at apogee over South America.

The magnetometer operated perfectly on a *Javelin (Argo D4)* sounding rocket launched Dec. 12 from Wallops Island, Va. The *Javelin* payload, weighing 35 lbs., rose to an altitude of 717 miles and telemetered data during the entire length of its flight. The *Javelin* payload was much lighter because it required only about 7 lbs. of batteries, good for up to 10 hours of operation, instead of 35 lbs. as in P-14, and the *Javelin* payload was not spin stabilized. *P-14* will carry lead weights on the outside to steady the spin.

The spacecraft, a large cylinder with a smaller sphere at the end of a rod extending from the cylinders' axis (see illustration) will carry two other scientific experiments, weighing a few lbs., in addition to the rubidium magnetometer. The main cylinder is constructed of magnesium, the sphere of a fiber glass plastic composition like that in the *Altair* rocket case. ⁂



*DISASSEMBLED P-14 magnetometer showing (center) arrangement of dual rubidium gas cells and rubidium excitation lamp with the cannister.*

# More Blue Scout Shots Scheduled Soon

***First test yields data from lower Van Allen belt, although capsule is lost; vehicle was biggest solid rocket fired from Cape***

*BLUE SCOUT I,* the three-stage member of the Air Force family of all-solid sounding and orbital rockets, lifted a 392-lb. payload to 1000 miles altitude and plunged into the Atlantic 1200 miles down the Atlantic Missile range on its first flight test.

The research rocket radioed telemetry data from eight experiments during its stay in the lower reaches of the Van Allen radiation belt Jan. 7. On return, a 90-lb. instrument capsule separated and fell by parachute into the ocean northeast of Antigua.

A JC-54 search plane followed the radio beacon and spotted the capsule in the water late in the afternoon. However the recovery ship Coastal Crusader, 200 miles away, could not reach the area until the following morning; the capsule had disappeared by then.

It was understood that the distance traveled was somewhat short of the Air Force objective.

The stages of the 72-ft. *Blue Scout I* are identical with the first three stages of the *Scout,* developed by the National Aeronautics and Space Administration, except that it contains a destruct package and controls required to satisfy AMR regulations. No destruct package is required for *Scout* vehicles flown from the NASA station at Wallops Island, Va.

The *Blue Scout,* weighing 36,900 lbs., about 3900 lbs. heavier than *Polaris,* was the largest solid propellant rocket ever flown from Cape Canaveral. The record, however, will stand only until the 65,000-lb. *Minuteman* ICBM flies in the next month or so.

It was the second of the *Blue Scout* family to be tested. A smaller version, the *Blue Scout Jr.,* a 40-ft. vehicle whose first stage is the second stage of regular members of the *Scout* series, had one success in two flights last fall.

• **More shots soon**—The Air Force plans to test the two other members of the *Blue Scout* family in the next few months. One is the Air Force *Scout,* identical to the four-stage NASA *Scout* except for beefed-up structure between final stage and payload, and a large payload compartment. The other is *Blue Scout II,* which has guidance in the fourth stage. The other regular *Scouts* have a semi-inertial guidance package in the third stage. *Blue Scout Jr.* is unguided.

Aeronutronic Division, Ford Motor Co., is the Air Force's prime contractor on the *Blue Scouts.* Chance Vought, NASA's prime *Scout* contractor, is a major Air Force associate contractor in charge of vehicle assembly. *Blue Scout I* propulsion contractors are Aerojet-General, Thiokol and Hercules Powder Co. Minneapolis-Honeywell developed the guidance.

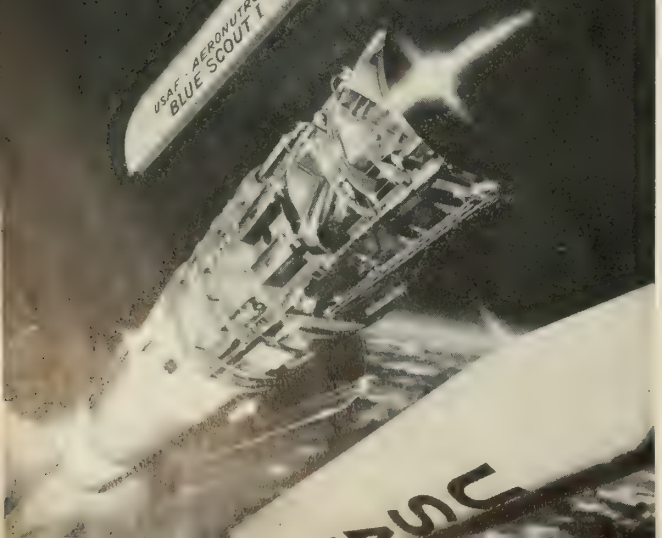
Both the Air Force and NASA plan to use *Scouts* for testing vertical and angular launch techniques, boost-glide and boost-dive trajectories and recovery techniques. A number of *Blue Scout* shots are programmed for support of the *Dyna-Soar* development.

• **PMR possibility** — Most *Blue Scout* launches are scheduled for Cape Canaveral. However, several tests involving polar orbits may be fired down the Pacific Missile Range. The *Blue Scout* R&D phase, comprising 12 launches, is scheduled tentatively for completion when the current fiscal year ends in June. However, since NASA also is testing *Scouts,* Air Force technicians hope the NASA results may eliminate the need for two or more tests.

The 1962 AF budget request will include *Blue Scout* production funds.

The eight experiments aboard were aimed at measuring radio frequency background radiation in the 50 cycles 100 kilocycles band; concentration, size and flux of micrometeorites; flux of backscattered albedo neutrons; concentration and energy distribution of charged particles in the upper atmosphere by time and position; electronic signals above and below the ionospheric cutoff; ion density in the upper atmosphere; aerodynamic turbulence along the launch vehicle surfaces and acoustic and vibration environment of the payload, and radiation dosage for evaluation hazards to manned flight.

The 90-lb. capsule carried a miniature tape recorder to register velocity and payload temperatures.




*BLUE SCOUT payload sheds heat shields in artist's conception. Air Force reported satisfactory telemetry from all eight experiments, despite failure to recover capsule.*

## Bell Set Record in 1960 For One-Year Profits

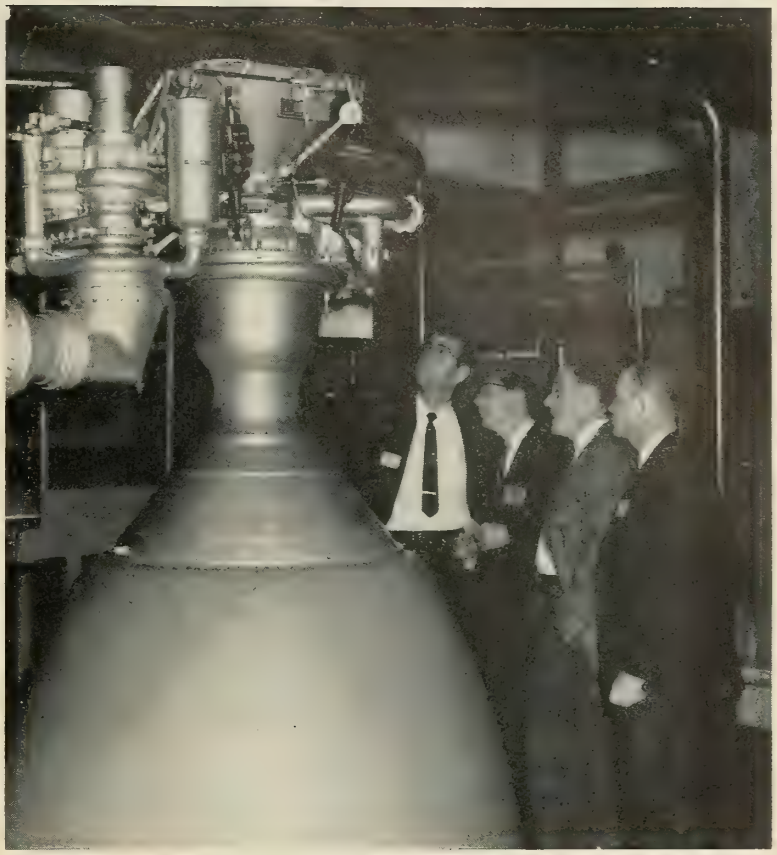
THE BELL SYSTEM showed more profit in the twelve months ended Nov. 30, 1960, than any company has ever cleared in a year.

American Telephone and Telegraph Company and its telephone subsidiaries had an income of $1,244 million. Previous high for any company was set by General Motors Corp., $1,189 million in 1955. The Bell System posted $1,136 million in profits last year.

Bell is "hopeful" that it will be able to launch a communications satellite within a year, according to president Frederick R. Kappel. The company is preparing to furnish intercontinental telephone and TV channels through satellite communications systems, he disclosed.

The Bell System has applied to the Federal Communications Commission for microwave radio frequencies for experimental use.

**Magnavox Co.**—The highest levels of sales and earnings in the company's fifty-year history were attained. Earnings for 1960 rose by about 40% to 6.5 million from the $4.7 million the previous year. Sales rose 15.5% to $124.5 million from $107.8 million the previous year. The company reported that its military and industrial electronics products division increased its sales 35% for the twelve-month period, and doubled its fourth quarter of a year ago.



### *Titan II 2nd-stage Engine*

*FIRST PHOTO of Aerojet-General's mockup of the second-stage engine for the advanced Titan II ICBM, taken during a review at the company's Sacramento plant.*

## corporate changes

**NATIONAL RESEARCH CORP.** has purchased a controlling interest in Vacuum Apparatus Company, Palo Alto, Calif.

**GENERAL ELECTRIC's** Silicone Products Department will construct a $1-million process plant devoted to production of new types of intermediate silicone chemicals. The Department, at Waterford, N.Y., also has under construction a $1-million silicone fluids finishing operation and a $3-million plant for the manufacture of silicone chemicals intermediates.

**AMERICAN MACHINE AND FOUNDRY** has acquired Paragon Electric Company of Two Rivers, Wis., subject to a Paragon's shareholder meeting.

**HUGHES AIRCRAFT COMPANY** and SABCA, a Belgian aircraft corporation have formed a new company in Belgium. Named COBELDA, the company will provide technical assistance and maintenance for electronic equipment deployed in Europe and support service for the Hughes ground and airborne radars on the continent.

**U.S. INDUSTRIES, INC.'s** Western Design and Electronics Division has completed negotiations to build a 60,000-square-foot office and plant facility in the Goleta Valley outside Santa Barbara.

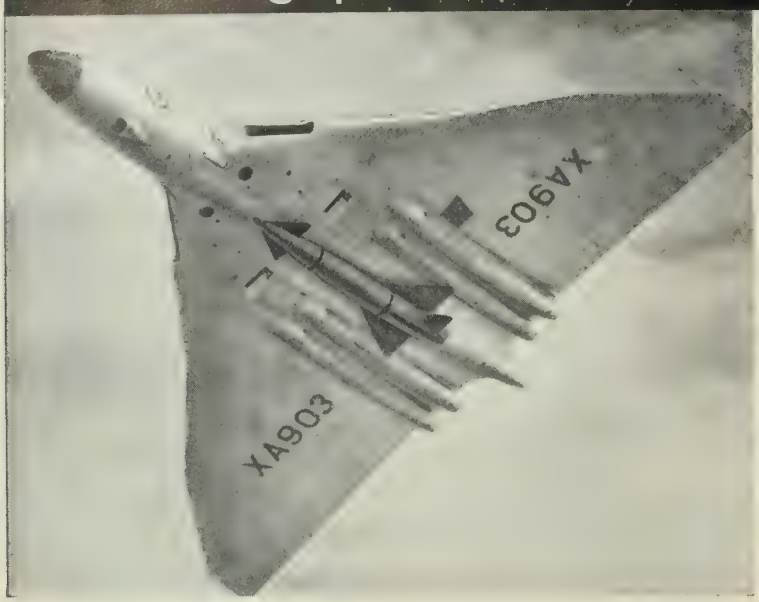
**AEROSPACE RESEARCH INC.** has been formed by L. Dennis Shapiro, former chief of space research section, Pickard and Burns, Inc. The firm will be located in Cambridge, Mass., and specialize in research and development in radio propagation, communications and ionospheric physics.

**GENERAL MOTORS** will move its Aeroproducts Operation in Vandalia, Ohio, to the Allison Division at Indianapolis, pending Air Force approval. Plans are being made to utilize the Vandalia facilities for other production within less than a year.

**BECKMAN INSTRUMENTS INC.** has begun construction of a $1.25 million building to house its Systems Division at the company's Fullerton, Calif., headquarters plant. The 100,000-sq.-ft. building will be occupied in May, 1961.

**FORD MOTOR CO.'s** Aeronutronic Division has changed the name of its Research Operations to Research Laboratories . . . American Radiator and Standard Sanitory Corp.'s Detroit Controls Division will be known as the American-Standard Controls Division.

# Britain's new deterrent system relies on two high-performance vehicles...






# ...AND BRISTOL SIDDELEY SUPPLY THE POWER

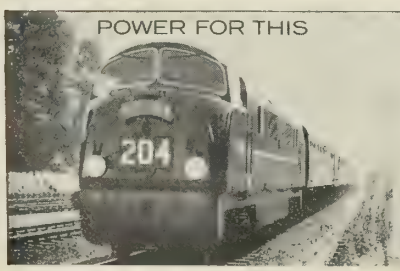
Bristol Siddeley Engines Limited produce the powerplants for two vehicles which make up the most advanced weapon system within Britain's strategic deterrent force—the Avro Blue Steel "stand-off" bomb and its carrier aircraft, the Avro Vulcan V-bomber.

**The Bristol Siddeley Stentor** liquid propellent rocket engine powers Blue Steel. The Stentor is a high-thrust engine which burns kerosene and hydrogen peroxide. Its exceptional performance enables Blue Steel to be released from the carrier aircraft *well outside the enemy's defence zone.* Blue Steel, which can be more accurately described as an air-to-ground missile, then continues under its own power and seeks out the target with great accuracy while the carrier aircraft returns to base.

**The Bristol Siddeley Olympus** turbojet, Britain's most powerful military aero-engine, powers the Avro Vulcan, and gives this delta-winged carrier of Blue Steel sonic capability, great range, high altitude.

**BRISTOL SIDDELEY ENGINES LIMITED**

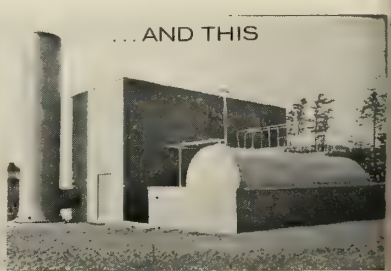
Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Telephone: University 6-5471




**Bristol Siddeley Maybach** diesel engines power the British Railways "Bristolian".




**The Bristol Siddeley Marine Proteus** powers the "Brave" class 96 ft. Royal Navy patrol boats.




**The Bristol Siddeley Industrial Proteus** gas turbine engine powers a 3-megawatt turbo-generator.



Circle No. 7 on Subscriber Service Card.

# Technical Countdown

## ELECTRONICS

### PARADE: Still a Silent March

The Army's very-secret PARADE (Passive-Active Range Determination) still is wrapped in impregnable security. Funded by Ordnance at Redstone Arsenal, ($3.1 million, so far) Sylvania is believed well under way with a prototype contract awarded last year. The electronic counter-countermeasures system has been under development by the company's Data Systems Div. since a study contract in 1955. A follow-on feasibility program was begun in 1957.

### Global Radio Station Nears Completion

The Navy's two-megawatt global communication station at Cutler, Maine, has successfully passed preoperational tests. One year ahead of schedule, the nearly complete $50-million station uses the world's most powerful transmitter for communication with operational *Polaris* submarines. Continental Electronics Mfg. Co., a subsidiary of Ling-Temco, is prime contractor for the complete installation.

### New Look at Universe Coming Soon

A series of ultraviolet telescope packages will soon be carried in *Aerobee-Hi* rockets to an altitude of 150 miles over Wallop's Island for Project *Celescope*. Carrying a Uvicon—an ultraviolet sensitive tube developed by Westinghouse—the system will employ TV techniques for celestial observations above the atmosphere. This will be an early test of one of several instrument packages destined for use in NASA's orbiting astronomical observatory satellite (*OAO*) due for launch in 1963.

## SUPPORT EQUIPMENT

### 'Do-It-Yourself' ComputerMat Established

Computer time on a self-serve basis has begun with the opening of the first of several "ComputerMats" planned for the Los Angeles area by ComputerMat, Inc. The new "do-it-yourself" computer center uses an IBM 1620 transistorized, decimally operated, core memory computer. The decimal 1620 allows an inexperienced operator to solve his own engineering and scientific problems with a minimum of instruction.

### Ideas Needed on Weather Data Reduction

Dr. Morris Tepper, NASA chief of weather satellites, is looking for good ideas for analysis of weather observations aboard the advanced *Nimbus*, to reduce the flood of data that will be transmitted to the ground. He says he will be receptive to any specific plan of data analysis from anyone who understands meteorology. Data storage aboard the satellite is one possibility.

### Pershing Explosion Unrecorded

Lack of good news photos of the spectacular *Pershing* blowup of Jan. 5 was attributed to inadvertent lockup of a tracking camera. By the time the camera was unlocked and operating again, all that remained of the missile was bits and pieces falling back to earth.

## MATERIALS

### Price of Fluorocarbon Resins Reduced

Responding to an expanding market and manufacturing economies, DuPont has reduced the prices of its "Teflon" resins. The basic resin now stands at $3.25 per lb. in truckload lots. "Teflon" 100 FEP-fluorocarbon resin, useful in wire and cable applications, was cut to $9.60 per lb.

### Computer to Tackle Space Thermal Problems

Douglas Aircraft has ordered a thermal analog computer for use in the *Saturn, Skybolt* and *Nike-Zeus* programs. Thermal problems associated with re-entry and space payloads may be simulated and varied in seconds by rotating a switch. Computer Engineering Associates is building the instrument, which will include 29 special thermal radiation units.

### Copper Joining Process Reduces Cost

A special coating on the surfaces of copper metals to be joined diffuses into the parts and, under certain conditions produces a homogeneous bond without an interface. Chase Brass & Copper Co., developed the method. Complete diffusion, braze, and combined diffusion and braze bonds are possible. The joints retain virtually all of the electrical and thermal characteristics of copper.

## PROPULSION

### NASA Reduces Space Payloads

NASA's chart of launch vehicle capabilities has reduced several figures in the interest of realism. New payloads: *Scout*, 150 lbs. in orbit instead of 150-200 lbs.; *Thor-Agena B*, 1250 lbs. in orbit instead of 1600 lbs.; *Atlas-Agena B*, 5000 lbs. in orbit instead of 5300 lbs., and 750 lbs. to escape velocity instead of 800 lbs.; *Saturn C-1*, 19,000 lbs. in orbit instead of 20,000 lbs., and 5000 lbs. for escape instead of 9000 lbs. *Centaur* retains the same orbital capacity—8500 lbs.—and its escape capability rises from 1450 lbs. to 1500 lbs.

### Aerobee to Research Hydrogen Weightlessness

NASA is planning to launch an *Aerobee* sounding rocket from Wallops Island in the next few weeks to observe what happens in a 9-in. sphere partly filled with liquid hydrogen during five minutes of weightlessness. A camera will record how the cold liquid is distributed in the sphere to provide data that will help in designing the *Centaur* for restart in space. The 250-lb. payload will reach 118 miles altitude and is designed for both air snatch and recovery from the sea if snatch fails.

### Work Begun on No. 2 Saturn

Huntsville has begun construction of the second flight *Saturn*, while work is finishing on the first, due to be static-tested after the current series of tests is completed on the prototype booster. Meanwhile, an extension to the Fab Lab is being built to make possible simultaneous construction of three boosters.

# Will USSR Lead in Applied Math?

***Russians are doing better job of coordinating the theoretical and the practical, RIAS reports, with strong stress on plant automation***

*The opinion is sometimes advanced that the new technological revolution in the Soviet Union will be the practical use of atomic energy as the most powerful source of energy. This is not the case. In fact, it is automation moving productive processes under their own power that today plays the same decisive role that was played by power machines in the industrial revolution of the 18th century.*

(From a report of a meeting of the academic Council of the Institute of Automation and Telemechanics of the Academy of Sciences, USSR, May, 1959.)

**by William Beller**

THE SOVIET UNION may soon pull ahead of the United States in applied mathematics.

In theoretical mathematics, the USSR is equal to the U.S.

The USSR is putting strong emphasis on the mathematics of automatic control problems. It appears that through automation—through accurately guided spacecraft and automatic factories—the country hopes to prove its technical superiority.

In addition, the USSR seeks to show that only a communist society can carry out the automation of industry without a breakdown in its economy.

These are some of the conclusions reached by a star panel of mathematicians organized by RIAS (Research Institute for Advanced Studies) to report on recent Soviet contributions to mathematics.

The panel points out in its year's study that the USSR encourages the application of mathematics by its mathematicians. This is in sharp contrast to the U.S. where there is a growing gap between pure mathematicians and those interested in applications.

The panel adds that there are a large number of Soviet mathematical-engineers who keep up with the latest mathematical developments and use them in practical work. There is no counterpart to this group in the U.S.

Here are other observations made by the panel:

–Soviet mathematicians strive to communicate the latest theoretical advances to engineers and scientists. In the U.S., specialists write for each other.

–Applied mathematics is respectable in the USSR. For this reason, the field is attracting many young people. On the other hand, among the pure mathematicians in the U.S. there is an increasing tendency toward greater and greater abstraction.

This tendency is discouraging young mathematicians from even looking at applications. Partly by U.S. default then, the Soviet Union will be gaining

## Martin's Answer: RIAS See



BENDER

THE MARTIN COMPANY set up the Research Institute for Advanced Studies (RIAS) in 1955 to see if basic research could be made into a respected investment for private enterprise and the government.

RIAS' books have yet to show a profit. Still, the organization is now meeting about half its expenses. The intangible rewards to Martin are felt to be making up the difference.

One such reward stressed by Martin board chairman and chief executive officer George M. Bunker is that "RIAS opens to Martin engineers a window of science that didn't exist before."

RIAS is made up of about 90 top research scientists working in manor house surroundings on an estate north of Baltimore. They are engaged strictly in searching for knowledge—whether or not it has any practical use.

There are staff members studying biochemistry and the biophysics of photosynthesis. Others are looking into the concepts of quantum chemistry and the phenomena associated with superconductivity. There is a group of 15 mathematicians whose only responsibility is to learn more about mathematics.

• **Increases general welfare**—The organization's first and present director, Welcome Bender, is a purposeful man who spearheaded the concept of RIAS. He is energetically trying to sell to other companies and the government the idea that "basic research is a national resource and should be exploited."

"We must do something to make basic research attractive," Bender insists. He says that even though we lead the world in technology, we are not operating at our maximum because we don't have the basic research inputs. "Science—which buttresses technology—has not had nearly the expansion that technology has had."

Bender calls the financing of basic research a government responsibility. He says that under the Constitution the Congress is charged with providing for the general welfare. "What is more relevant to the general welfare than basic research?" he asks.

The RIAS director bristles at what he calls a current concept that basic research should be subsidized, "like a poor relation." He maintains that i

in applied mathematics.

–An increasing number of Soviet mathematicians are working on control theory and numerical analysis. In quality of work, they match the U.S. In quantity of output and in number of people in the field, the USSR leads the world.

–Mathematics and mathematicians are protected by their own prestige in the regulated USSR society.

–Mathematics books in the USSR are amazingly cheap and good. In price, the U.S. books can not even compete. This gives the Soviets an exquisite scientific weapon and in addition a means to influence scientists in other countries.

• **Control and stability**—Mathematical research in the theory of control is carried on at two levels in the Soviet. In the first, there is a strong group of pure mathematicians developing a general theory of optimal control. They are also working on problems in differential equations and stability that relate to control theory.

On the second level, there is an equally strong group comprising mathematical-engineers. It is more directly concerned with applications. Mathematicians in the U.S. call members of this group "engineers" while American engineers who know them call them "mathematicians."

The mathematical-engineers are described as making important mathematical contributions and following closely mathematical research, working on engineering problems, and interpreting and transmitting mathematical results to engineers.

This group is reported to be better informed about the work of American mathematicians on control theory than are American engineers.

The panel observes that the USSR is "mounting a total scientific effort in automatic control." This effort is contrasted with that in the U.S. where "there is no balanced program . . . (and) where developments in automatic control are primarily in the hands of engineers."

Because of the Soviet's greater effort in the mathematics of control and stability, the panel sees the USSR's progress in the field being faster and theories being applied earlier than in the U.S.

• **Numerical analysis**—The USSR is giving much attention to computers and the related fields of data processing and automatic control equipment. As a result, a large part of the world's research in numerical analysis, of excellent quality, is being done in the USSR.

Books on numerical research are being produced in mammoth editions. They are widely distributed and frequently written to appeal to large, relatively unspecialized audiences.

An example cited is Sobolev's book on applications of functional analysis in mathematical physics; and to the exposition of Panov on numerical methods for solving hyperbolic differential equations, oriented toward engineering applications.

The most outstanding Soviet mathematicians are said to be taking a keener and more active interest in numerical analysis and computational methematics than their Western colleagues. This can not help but give strong impetus to the growth of Soviet numerical analysis and also to computer design.

• **Statistics**—The quality of the work in probability theory, information theory and mathematical statistics in the USSR is on the same level as that in the U.S. Much of the work has been done in two areas of practical interest —queuing theory and statistical quality control.

Because of the importance of applied statistics, there have been many Soviet books derived from the subject. These range from a text on least squares by Linnik, written for mathematical statisticians, to books by Cebotarev and Lukomomskii written for workers in geodesy, and for engineers and economists, respectively.

The full report of the RIAS panel will be published this spring by The Macmillan Company.

The panel members were: J. B. Diaz, Univ. of Maryland; Robert Fortet, Inst. of Henri Poincare; J. H. Giese, Ballistic Research Lab., Aberdeen Proving Grounds; R. A. Good, Univ. of Maryland; J. P. LaSalle, RIAS; Solomon Lefschetz, RIAS; Tadeusz Leser, Ballistic Research Lab.

Eugene Lukacs, Catholic Univ.; Ceslovas Masaitis, Ballistic Research Lab.; Edith Mourier, Univ. of Poitiers; J. Neveu, CNRS, Paris; Lajos Pukanszky, RIAS; H. A. Steeves, RIAS; and A. P. Stokes, RIAS.

## nowledge for Its Own Sake

should no more be "subsidized" than should road-building or the Navy or missile-building. He declares that basic research can pay its own way—by increasing the country's culture and its well-being.

Quoting a National Science Foundation study by Raymond Ewell, Bender points out that "the increments to gross national product in new business spawned out of basic research in the last quarter of a century amounted to $25-$50 for each dollar spent."

• **Big job, little money**—The traditional methods of financing science are inadequate, Bender maintains, for the following reasons:

–There is no longer enough philanthropic money in the universities to pay for the research demanded by our expanding gross national product.

–The cost per increment of new knowledge has expanded more than the normal inflation because new knowledge is harder to come by.

–Government laboratories, because of their lack of competitive atmosphere and their relative inflexibility, have a problem getting and keeping top talent except under wartime conditions.

–For industry, the pay-off appears to be far away—and in general is not proprietary.

• **Who pays the bill?**—One of the biggest impediments to basic research is the fact that a man with an idea is often actually penalized. "Several (government) agencies hold to the rule that if the subject of research is suggested by the agency, it is willing to support full costs; but if it is suggested by the research scientist, it is only willing to support a part of the cost."

The government also seems to be continuing with the old idea that somewhere there is a good philanthropist who will pick up at least part of the tab for basic research and then give its results freely to the world.

As a matter of fact, "To insure the continuance of this vestigial attitude, Congress has put statutory and abritrary limits on grants from NSF and NIH, which hold government participation to direct costs and 15% of indirect costs," says Bender.

However, Bender points out that the picture is not all black. With the establishment of ONR after the war—then ARDC, OSR, OOR and the many technical services of the military—an increasing emphasis on basic research has been realized. The AEC, NIH, NSF and now NASA are additional agencies deeply involved in using tax dollars in the interests of science. ⌗

# New Drive Should Enhance Missilery

## *Harmonic Drive—based on brand new concept of transmitting motion through deflecting members—offers solutions to radar and other problems*

**by Richard W. Daniels**
*Director, New Product Development*
*General Industry Group*
*United Shoe Machinery Corporation*

A NEW PRINCIPLE of mechanics that uses controlled deflection of operating members to transmit, convert or control mechanical motion is being applied increasingly in the missile field.

Besides being useful for driving, tracking and airborne radar antennas, it appears to be ideal for transmitting power through hermetically sealed housings or bulkheads.

The requirements for small-size, lightweight and high reduction ratios for radar drives, whether for ground based installations or airborne systems, has been of some concern to missile designers for several years. Moreover, the problem of minimum—in some cases practically zero—backlash, plus the need for high torque capacity and low friction losses, has further complicated the design of transmissions using conventional spur or planetary gearing.

The development of a compact, high-efficiency drive that operates on the principle of controlled deflection of the transmission elements now gives promise of overcoming many of these previous difficulties. In fact, if the success of the military installations that have been made to date is any indicator, its advantages may well prove to be a significant contribution to the missile field.

Still another use receiving increasing attention of late is for component and control drives in missile engines and navigational gear. Hardware for this purpose has already been delivered, and many other designs are in the prototype or engineering stages. In this case, it is the ability of the drive to transmit rotary-to-rotary, rotary-to-linear, or linear-to-rotary motion through hermetically sealed enclosures that interests the missile industry.

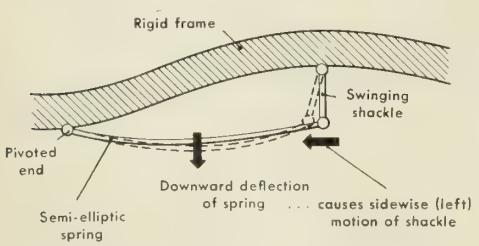



**Fig. 1**—*Leverage and motion conversion are obtained by controlled deflection of operating elements.*

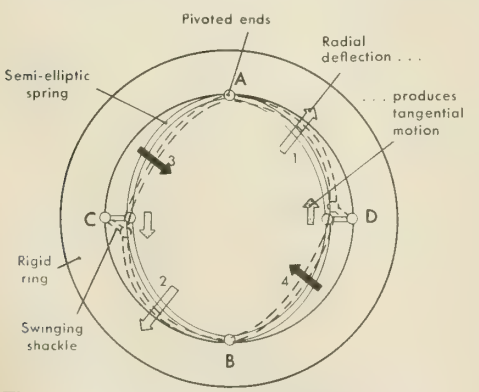



**Fig. 2**—*Applying same principle in a circular member converts radial deflection to tangential motion.*

The exact nature of other applications that may develop in the future is difficult to predict at this time. But the fact that Harmonic Drive represents a completely new mechanical concept is certain to set designers thinking. Heretofore, mechanical transmissions have been designed around the principles of rigid body mechanics. They utilized elements whose deflection, if any, was purposely made minimal.

In contrast, Harmonic Drive devices, based on the elasto-kinesis principle, contain elements that are deliberately deflected when in operation. Such drives can be designed to provide speed reductions of up to millions to one; to provide a high torque rating, high torsional rigidity, and high operating efficiency; and to offer other advantages, such as zero or reduced backlash and less windup under load. Morever, rotary-linear versions can provide extremely fine and accurate positional control.

### Leverage by Controlled Deflection

While there are many variations of Harmonic Drive, the basic principles involved can best be explained through development of the rotary to rotary motion transmission. All forms of Harmonic Drive utilize a traveling deflection wave and the motion conversion which results from an advancing wave shape.

In Fig. 1, a simple example of "leverage by controlled deflection" is illustrated. Here, a semi-elliptic spring is shown with one end mounted on a fixed pivot, and the other attached to a swinging shackle. A downward deflection of the spring increases the spring curvature, decreases the chord length, and causes the swinging shackle to move to the left. A form of right-angle lever thus results from the spring deflection action of Fig. 1, and is capable of high force leverage or mechanical advantage.

In Fig. 2, semi-elliptic springs are mounted within a rigid circular ring, and are pivoted at points A and B and attached to swinging shackles at points C and D. An outward radial deflection in regions 1 and 2 increases spring curvature in these regions, but decreases curvature in regions 3 and 4. As a result of this radial deflection, the swinging shackles at C and D move tangentially as shown.

### Harmonic Drive as a Rotational Machine

The final step to convert the simple spring deflection system into a continuous rotational machine is shown in Fig. 3. Here, two toothed parts are employed which mesh together in a manner similar to splines. The outer part is a rigid circular ring with internal spline

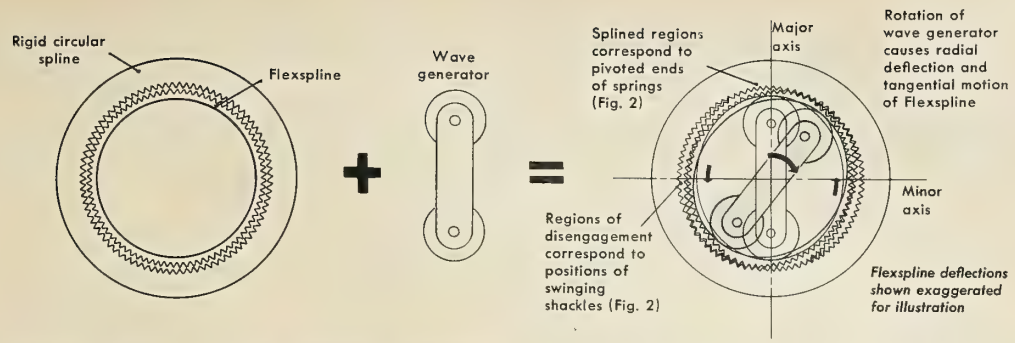



**Fig. 3**—*Schematic diagram of a basic three-element Harmonic Drive. The wave generator—in this case a two-element roller—can also take the shape of an elliptoidal cam in the form of an elliptical bearing or of a ball planetary generator.*

teeth; the inner part is a relatively thin flexible ring carrying external spline teeth. It is the unique functioning of this inner part, called the "Flexspline," that carries Harmonic Drive into the realm of non-rigid mechanics.

The third element in rotary Harmonic Drive is the "wave generator," which rotates within the Flexspline, deflecting it slightly from its natural circular form into an ellipse-like shape termed an elliptoid. The wave generator, in essence, provides the radial deflection force and radial displacement illustrated in the schematic structure of Fig. 2.

With the two-lobe wave generator shown in Fig. 3, the Flexspline is deflected into an elliptoid and meshes with the circular spline at two diametrically-opposite regions on the major axis of the elliptoid. Teeth of the two splines clear at the minor axis.

Teeth on the Flexspline and circular spline are cut to the same circular pitch, with the smaller Flexspline carrying slightly fewer teeth than the circular spline. To allow engagement at two diametrically opposite regions, the tooth arrangement must be symmetrical. For a two-lobe system having two regions of tooth engagement, the difference in number of teeth on the two splines must be 2, 4, 6—i.e., an integral multiple of the number of lobes. The pitch circle of the Flexspline is made smaller than that of the circular spline by an amount related directly to the difference in the number of teeth.

The splined regions of engagement in Fig. 3 correspond to the pivoted ends of the semi-elliptic springs in Fig. 2; whereas the minor axis regions of spline disengagement correspond to the positions of the swinging shackles of Fig. 2.

As the wave generator is rotated clockwise, the Flexspline is deflected progressively outward, causing continuous and greatly reduced tangential motion of the Flexspline. Motion of the Flexspline is in a counter-clockwise direction (CCW), for clockwise (CW) motion of the wave generator. For a

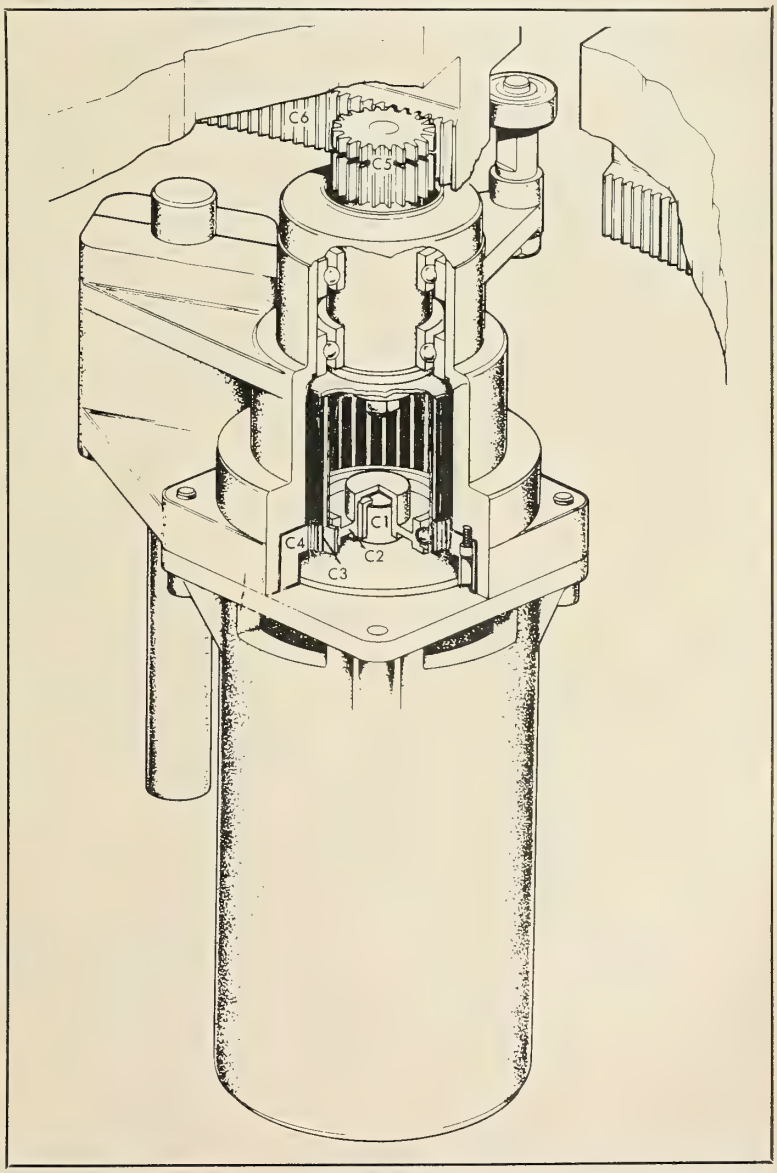



**Fig. 4**—*Speed reducer for the input to a radar tracking antenna has a reduction ratio of 172:1 and an output torque rating of 380 in.-lbs.*

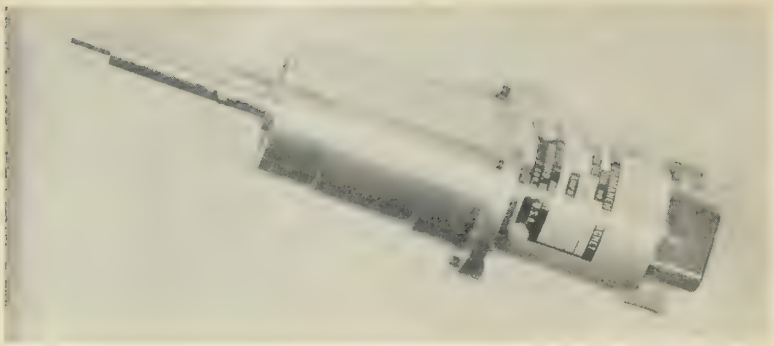


**Fig. 5**—*Small power servo designed for airborne radar system has 104:1 reduction ratio and a maximum output torque rating of 85 in.-lbs., is light and compact.*

full rotation of the wave generator, the Flexspline will counter-rotate by the difference in the number of teeth on the two splines.

The distinctive characteristics of Harmonic Drive can be seen from the simple rotary model of Fig. 3. The Flexspline and circular spline are firmly splined together at the major axis, but move angularly to one another at all other points, with maximum relative motion occurring at the minor axis.

If the wave generator is rotated clockwise (CW) at a constant angular velocity, the Flexspline will counter-rotate at a constant, but greatly reduced, average angular velocity in the counter-clockwise (CCW) direction. This is the basis for high reduction rotary Harmonic Drive systems.

## Missile Radar Drives

Three drives in particular, among the many that have been developed, give a good indication of the potentials for the transmission in missile radar. One is an azimuth drive for a ground tracking antenna; another is an extremely small, lightweight model that is being designed for one of our more advanced airborne missiles; and a third is a high ratio, 40,000 to 1 unit, that was developed for an azimuth drive for a satellite tracking radar system.

In the azimuth drive shown in Fig. 4, controlled deflection in the form of an advancing wave shape is generated by an elliptical ball bearing whose inner race is coupled directly to the output shaft of an electro-servo motor (C 1). The rotation of the bearing, or elliptoidal cam (C 2), causes the teeth on the circular spline of the flexible ring (C 3) to engage at the ends of its major axis with similar teeth on the inner face of the internal spline on the housing (C 4). These teeth then disengage at the ends of the minor axis. Since the Flexspline has two teeth less than the fixed internal spline, it progresses around the internal spline in the opposite direction to input rotation and at a reduced speed.

Two transmissions are used per antenna. Mounted on opposite sides of an external bull gear in order to balance the input torque and insure better control of rotation, they have an output torque rating of 380 lb-inches, and provide a reduction ratio of 172 to 1.

Primary advantages of this transmission are its small size, light weight and high reduction ratio. Measuring only 11½ inches long and approximately 6¼ inches high and 4¾ inches wide, it is approximately one-third the size and one-half the weight of a conventional spur gear drive. Each unit, in fact, weighs only 20 lbs., of which approximately 10 lbs. is accounted for by the mounting arm requirements that were established for the previous drive.

Equally important, backlash is less than 30 seconds. A unique anti-backlash device is incorporated in the design to eliminate backlash between the output pinion and mating bull gear. Another advantage in this application is the low

*(Continued on page 33)*

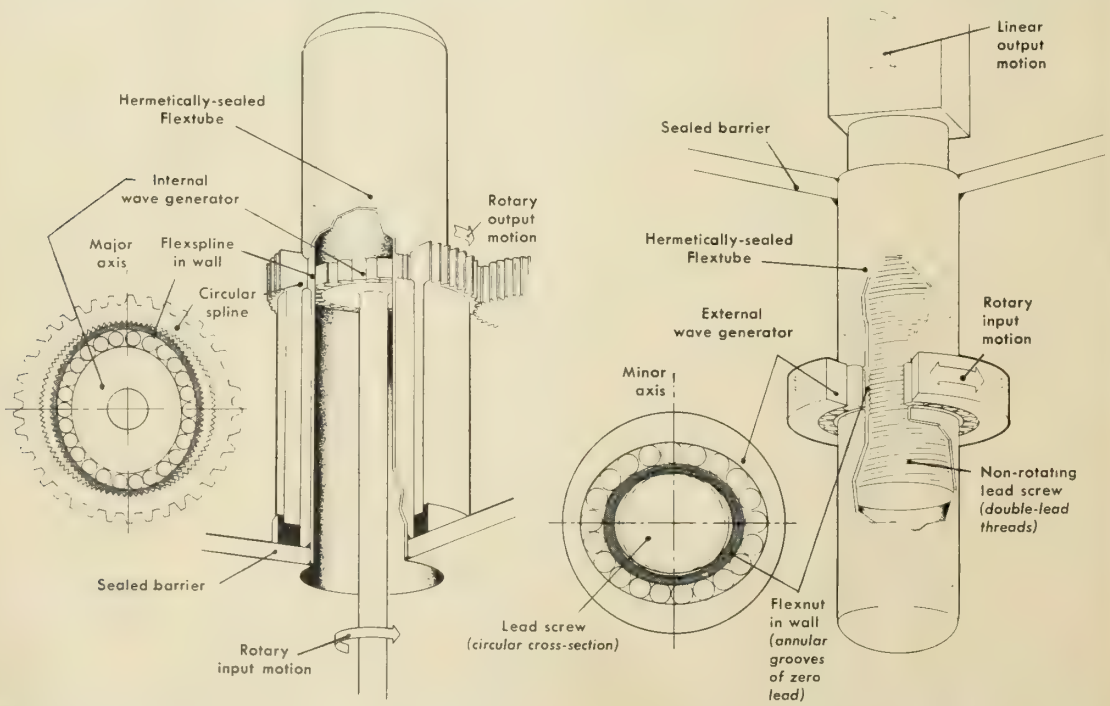



**Fig. 6**—*How Harmonic Drive can be employed to transmit rotary motion through a hermetically sealed barrier (at left), or to convert rotary input motion to a linear output through a barrier (at right).*

# Marshall's $70-Million Building Boom

PROJECT SATURN facilities will get the bulk of $70 million being spent for construction by NASA's Marshall Space Flight Center.

Funds will be about evenly divided between Cape Canaveral and the Huntsville Center.

Biggest single item in the budget for Huntsville is $10.8 million for a new *Saturn* booster static test facility. This facility is now being designed by Aetron Division of Aerojet-General with construction contracts due for award next fall.

Other *Saturn* work at Huntsville includes a $140,000 booster loading dock due for completion this month.

Contracts for building the $4.4 million headquarters and laboratory are expected to be awarded next June.

Facility modification and expansion at Huntsville includes:

–Pressure test cell, $650,000. Due for completion in June.

–Hydrogen test cell, $56,355. Due for completion this month.

–Addition to Guidance and Control Division building, $2 million.

–Addition to Fabrication and Assembly Engineering Div. building, $215,000. Construction contract in March.

–Addition to rocket checkout building, $4.5 million. Contracts in June.

–Expansion of Test Division industrial water system, $240,000. Contract to be let in February.

–Expansion of electrical distribution system, $579,000. Contract in May.

–Dynamic test facility, $609,000. Due for completion in March.

–Addition to buildings 4505-06, $2.5 million. Completion, January, '62.

–Vehicle maintenance building, $210,000. Contract award this month.

–Small construction, repairs, and alterations, $1.4 million.

Practically all the work on the schedule for Cape Canaveral is for *Saturn* facilities. Biggest item is for construction of *Saturn* Launch Complex 37, costing $20.8 million. Design contracts are to be awarded this month.

Other work at Canaveral:

–Completion of several parts of *Saturn* Launch Complex 34, $2.784 million. Includes hardstands for instrumentation sites, GSE installation, operations support building (contract to be awarded in March), and a liquid hydrogen system (yet to be designed).

–*Saturn* service tower escape system, $550,000. Design contract soon.

–Liquid hydrogen system for *Saturn* Complex 37, $2.5 million. Design contract due shortly.

–*Saturn* assembly and checkout building, $1.4 million. Design contract due in January.

–Addition to engineering and laboratory building, $300,000. Now in design; construction contract due in May.

–Engineering and operations building, $285,362. Completion in April.

–Modification to hangar for spacecraft preparation and checkout facility, $460,000. Now in design; construction contract expected this month.

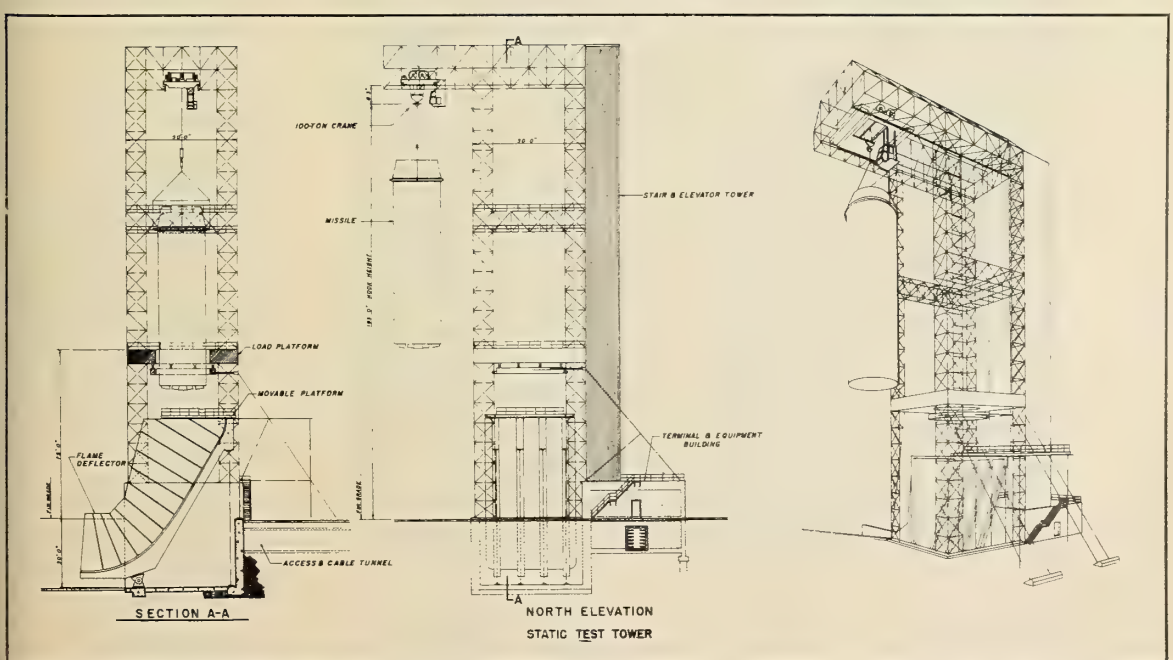
–*Saturn* service structure for Complex 34, $4.8 million. Scheduled for completion in April.

–*Saturn* Complex 34 pad and high-pressure gas system, $4.4 million. Due for completion in March.

–*Saturn* Complex 34 umbilical tower, $118,400. Completion in February.

–*Saturn* barge unloading facility, dock, and road, $170,000. To be completed in March.

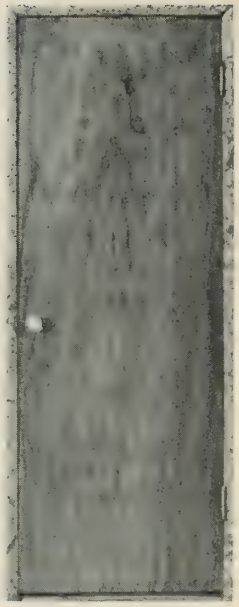
–Modification to building to accommodate a computer, $39,900. Under construction. ⌗




*SATURN STATIC TEST facility will cost $10.8 million, making it the largest single item in Huntsville construction budget.*



**POLARIS:** Northrop's Datico checks out Polaris at all levels of maintenance and operation



**SKYBOLT:** Guidance and navigation systems are being developed by Northrop for this new and highly secret air-launched ballistic missile.



**MERCURY:** The Northrop landing sy tem is designed to bring the Me cury astronaut down safely.

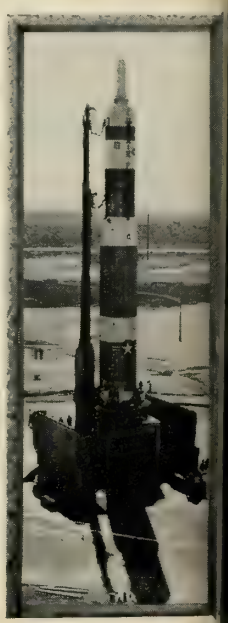
# Northrop is now active in more



**X-15:** Northrop produces Q-Ball, the flight angle sensor for safe re-entry of X-15 and other aerospace vehicles.



**AERODYNAMICS:** Northrop's Laminar Flow Control technique is designed to greatly increase aircraft range, flexibility, cargo and passenger capacity.



**TITAN:** Northrop supplies compli technical and industrial manageme to activate the T-2 Titan missile ba

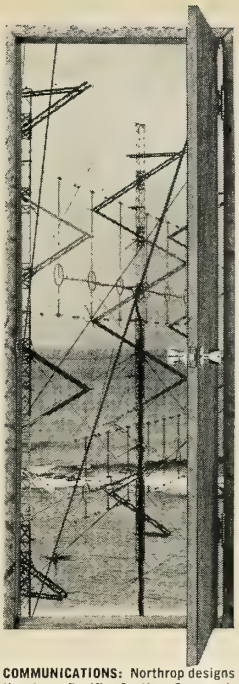
**Northrop Corporation, Beverly Hills, California** • Divisions: Norair, Nortronics, Radioplane, Northrop Internatio



Circle No. 8 on Subscriber Service Card.



**AWK:** Northrop produces airframe components, ground handling and launching equipment for this air defense missile.

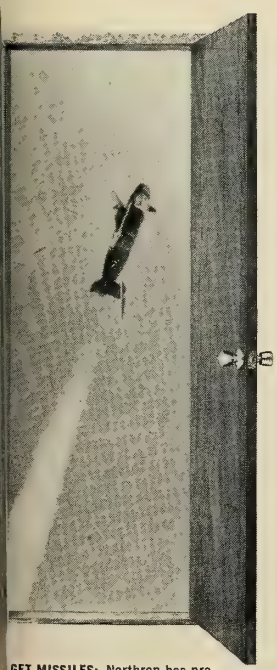


**COMMUNICATIONS:** Northrop designs the trans-Pacific Scatter Communications Network and other worldwide communication systems for U.S. and free world governments.



**T-38:** World's first supersonic twin-jet trainer is built by Northrop for the United States Air Force.

# than 70 important programs



**TARGET MISSILES:** Northrop has produced more than 50,000 electronically-controlled aerial targets, and surveillance drones.



**COMMERCIAL METAL PRODUCTS:** Northrop produces aluminum architectural shapes for many important industrial and commercial buildings.



**SPACE RESEARCH:** Northrop's accelerated space research programs reach into such advanced areas as maneuverability, rendezvous, space vehicle maintenance, space probes, and the survival of men in space.

Subsidiaries: Page Communications Engineers, Inc., Acme Metal Molding Company.

# Land-Air's White Sands Tracking

## *Pioneer in field utilizes 600 technicians, elaborate equipment to collect data*

A $6.5 MILLION CONTRACT has been awarded Land-Air, Inc. for missile tracking instrumentation and services at the extended White Sands Missile Test Center and the Aeromedical Laboratory, Holloman AFB, N.M.; Arctic Test Center, Fort Churchill, Canada; and the Project *Mercury* Tracking Station, Corpus Christi, Tex.

The Army Ordnance Corps contract provides for engineering, research, development, instrumentation services and responsibility for data collection at the three sites. Equipment used includes cinetheodolites, tracking telescopes, high-speed motion picture cameras, telemetry, radar, electronic trajectory and miss-distance measuring systems, time signal generation and distribution, communications and closed-loop television.

Land-Air currently employs some 600 people in the installation, operation and maintenance of the range instrumentation systems and technical photo supports. Through its White Sands Holloman Division, the firm has participated in missile and test-vehicle tracking operations since 1949.

The prime function of the tracking experts is to collect information on what happens to a missile prior to and during its launching and flight.

• **Procedure**—On a typical mission, such as the 45-90 minute test launching of a *Matador*, fixed cameras are mounted around the launch area to provide initial trajectory, attitude and launcher data. Then low-speed cinetheodolites photograph the entire flight to provide trajectory data and telescopes record periodically to provide event data.

Equipment for nighttime ground test of a Hypersonic Test Vehicle would include cinetheodolites, fixed cameras and ballistic plate cameras. The cinetheodolites are to provide secondary trajectory data, fixed camera for launcher data and intial missile trajectory, and ballistic plate cameras for time of events and trajectory data throughout the flight.

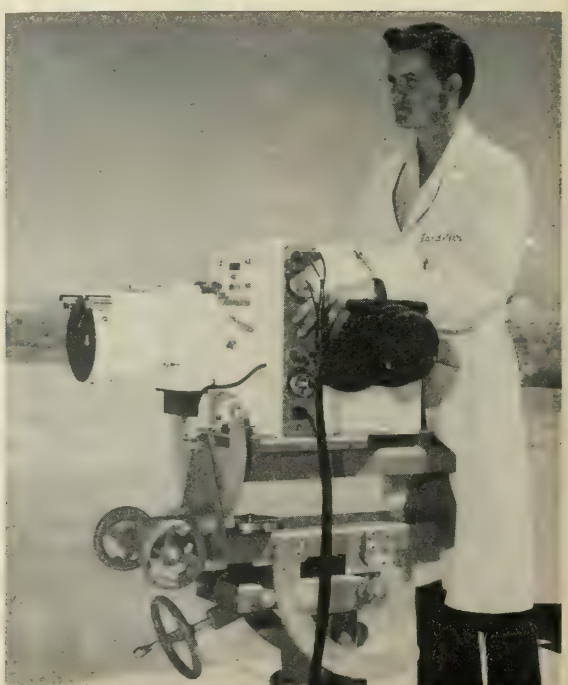
For recording data on a high-speed sled firing on AFMDC's 35,000-ft. track, fixed cameras are used to cover selected portions of the track to provide space-time data. In this type of operation, a number of the ribbon frame cameras are placed perpendicular to the track so that adjacent cameras have overlapping fields of view. Engineering surveillance, time-history, attitude and slow-motion studies of high-speed events are provided by high-speed cameras placed next to the track or in the tracking camera towers.

• **Deceleration data**—In deceleration tests (see photo upper right), Land-Air technicians are responsible for the mounting of subjects on the sled, operation of the propulsion unit, data collection instrumentation, and for maintenance and other mechanical support. Ultra-high speed cameras are used to photograph subjects during these tests.

On the subject's right arm is placed a blood pressure device. A chest pack holds accelerometers which give measurements from which G forces can



*TETRA (Terminal Trajectory Telescope) uses a Mitchell 70-mm camera to record flight, direction and final impact effect.*



*CLARK RIBBON frame-fixed camera provides data for time-history, attitude and other studies at Holloman sled track.*

be determined. Wrist and ankle "bracelets" are attached for recording electrocardiograph information.

The 120-ft. decelerator under the present propulsion system accelerates the sled to a velocity of 50 ft. per second over a 40-inch length. Considering this maximum velocity, the present system is capable of subjecting objects and dummies to 100 g deceleration; however, the majority of tests are in the 60-70 g range.

Other types of missions performed by Land-Air technicians include monitoring air-launched missile firings at balloon or parachute targets, ground-to-ground firings such as *Corporal*, and ground-to-air firings of *Nike* or *Talos* missiles.

After each mission is completed, the central control station takes a preliminary mission report from all of the stations consisting of test conditions. instrument operation, estimated time of coverage on each object such as the aircraft, missiles, and target.

On a maximum mission day, the Optical Measurements Group has exposed up to 30,000 feet of data film in the optical instrumentation equipment. The Land-Air group operates a multitude of various cameras on the range every day. These various instruments include 35 cinetheodolites to provide trajectory (position, velocity and acceleration), 13 permanent large telescopes and several mobile telescopes to furnish attitude, event, and precise miss-distance information.

The low-speed cinetheodolites are equipped with lenses from 20 inches to 118 inches focal length. The frame rate capabilities range from one per two seconds to 5 per second, with recording durations of 3 minutes to 30 minutes depending on frame rate. The high-speed cinetheodolites are equipped with lens focal lengths ranging from 60 to 180 inches. The frame rates obtainable are 10, 20, 40—with respective recording duration of 640 seconds, 320 seconds and 160 seconds.

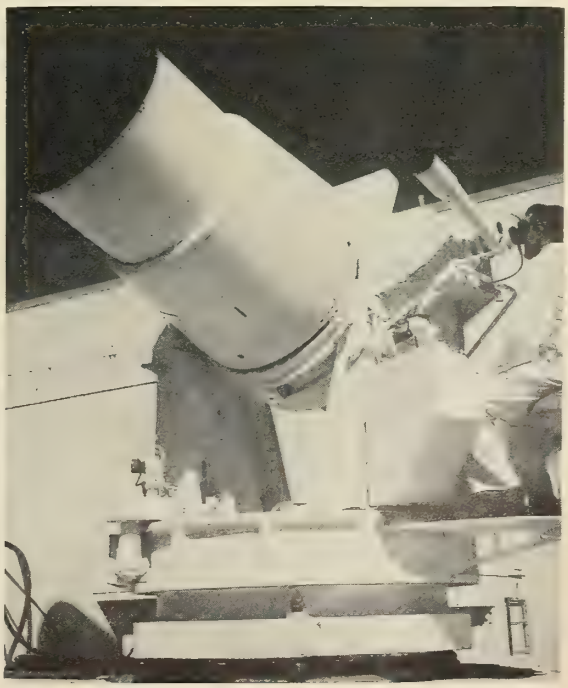
Land-Air, Inc. is a subsidiary of California Eastern Aviation, Inc., Washington, D.C., and is a pioneer in the missile tracking field. It has designed and fabricated much of the complex electronic equipment utilized in the studies, some of which is capable of accuracies within two parts in one billion. ⁂




*LAND-AIR TECHNICIANS attach instrumentation devices to test subject prior to deceleration. Fixed 35- and 70-mm cameras record results of sled experiment.*



*MODIFIED ASKANIA-WERKE cinetheodolite records trajectory, position, velocity and acceleration data from missile.*



*NEW MITCHELL telecamera uses a 30-in. primary mirror and 70-mm film to study missile behavior from launch to destruct.*

# Adaptable Swiss Aircraft Rockets

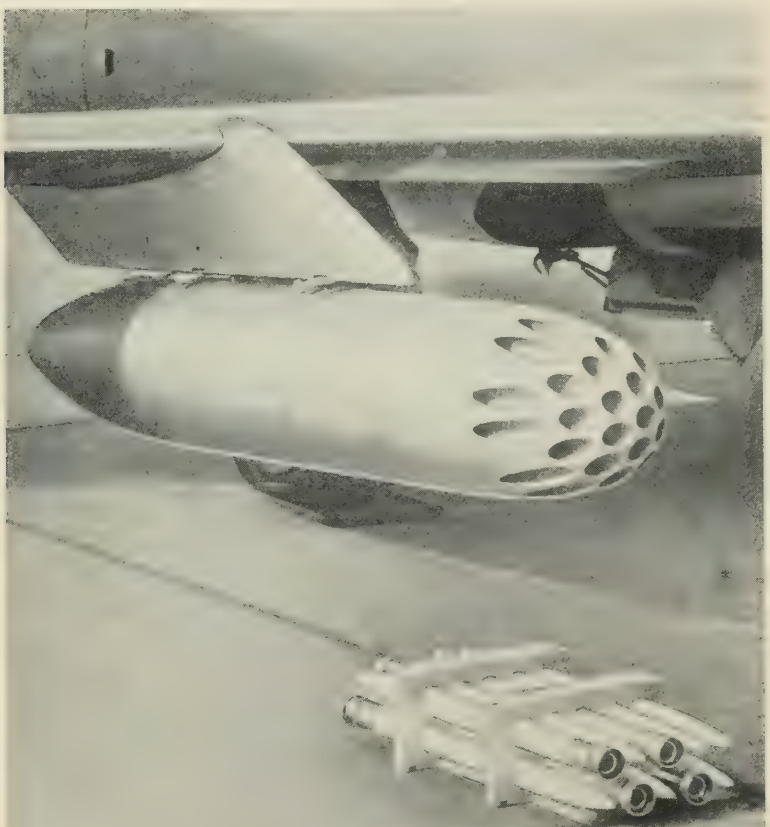
***Oerlikon system based on tiny 'black box' fills needs of many European planes; weapons meet USAF specification standards***

by Bernard Poirier

ROCKET STRIKE power, for troop support and aircraft defense, has been resolved for many European fighter and attack aircraft by Oerlikon's armament engineers in Zurich, Switzerland.

Their rocket weapons system grew from a requirement by several European aircraft manufacturers for a specific type of rocket fire power. The system would contain enough airborne weapons for repeated lethal passes at enemy strongholds during close troop support operations.

Oerlikon Machine Tool Works Buehrle & Co., whose constant development of modern arms often paradoxes the neutralist reputation of Switzerland, has merged rockets, launchers and electronic controls into a self integrated system which has been installed on Gloster Meteor and Venom jet fighters, the FIAT G 91 all-purpose NATO attack/fighter and on helicopters.



*FIGHTER AIRCRAFT carries 31-round airborne rocket launcher for 5-cm folding fin rockets, which are electrically fired and controlled by the intervalometer.*

Rockets, guided missiles and bombs are easily adapted to the Oerlikon system. The company manufactures all components and offers a choice of warheads and selective-type controls which can handle two to one hundred-twenty rockets on one aircraft—all through an ingenious "black box" about 3x3x3 in. in size. This gadget is the Release Box which is an integral part of any combination selected for an aircraft rocket system.

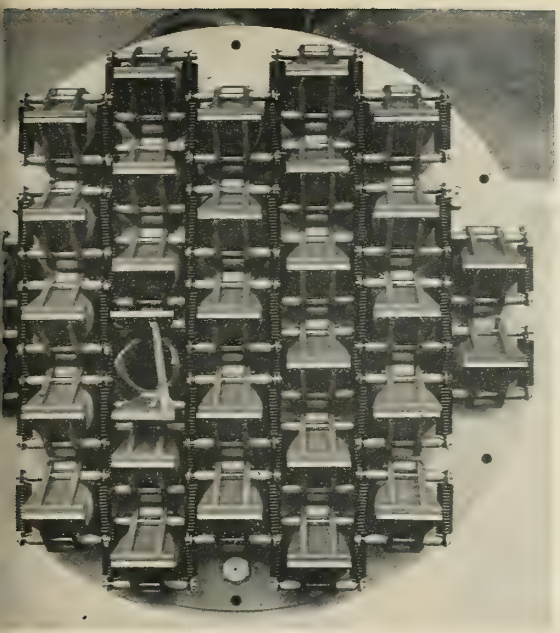
The most complete system includes fire button and main switch, single series and preselecting switch, shot counter, reset recording lamp and reset button, the release box, a nose wheel switch (for under fuselage rocket carriers) and a pre-fire check-out for the pilot.

To meet all eventualities as determined by specifications of various countries, Oerlikon has established quality controls and, in the case of one Italian customer, goes through 2000 switching actions and 8000 runs through the succession of selector contacts, without failures. During this time, the system is exposed to rapid changes within the range of operating temperatures, humidity and atmospheric pressures.

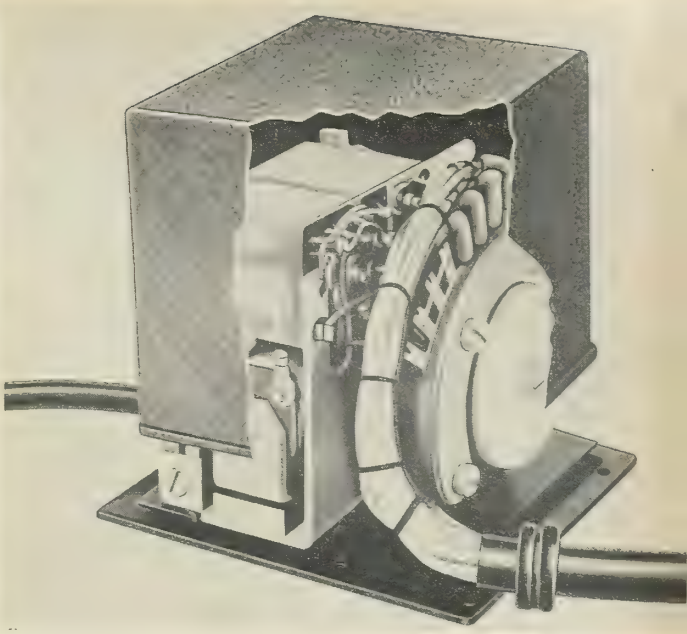
• **Attack mission determines size**—Oerlikon engineers fitted the system to military requirements. Two rockets of different strike power can be used, a 5 cm. size and the larger 8 cm. Each has characteristics which differ and offers certain advantages depending on whether a target might be an armored vehicle, train, artillery battery or an enemy aircraft.

Each has fins covered by a cylindrical cap which remains in the launcher at firing. This action compresses the folding fins which spring into position within a second of flight.

One foreign buyer demonstrated the system's killing power when an aircraft fired 72 five cm. rockets within 3.5 secs.



*REAR ENDS of launching tubes are closed by patented trap devices which open briefly to exhaust gases during firing.*



*OERLIKON ROCKET release box serves as control and release units for any type of aircraft rocket, measure only 3 x 3 inches.*

in a dive starting at 3950 and ending at 1640 ft. Twenty-four direct hits on a 10x10 ft. target were registered after the diving attack. Dispersion in air-to-ground delivery averages 1% with deviation most pronounced on the vertical plane.

An electrical impulse triggers the ignition through a selective unit in the cockpit. Pairs of rockets can be fired at time intervals of .1 sec. or less. The 5 cm. rocket thrust in the first second is 450 lbs. with the fins opening at .012 sec. from the pod or launcher. In this time period the rocket traveled about five feet.

• **Automatic blast**—The safety range of the rocket's flight is a feature of the impact fuzed warhead or charge. It will not detonate in the first 65 feet even when penetrating metal three times as thick as metal capable of activating the explosive beyond this point in flight. Pyrotechnical destruction occurs automatically about six seconds after the rocket has traveled 170 feet. Total effective range is not given.

The armor-piercing shell with a hollow charge, featured particularly in the 8 cm. rocket but also available with the other, has a longer safety zone but the charge explodes instantaneously upon contact.

Fragmentation warheads, on the other hand, have the safety feature of the hollow charge and the pyrotechnical action of the impact fuze.

The firing and rocket release mechanisms have been designed with enough simplicity to be integrated easily with fully automatic controls which may be standard on an aircraft. They can also function with a radar aiming device for engagement of enemy aircraft.

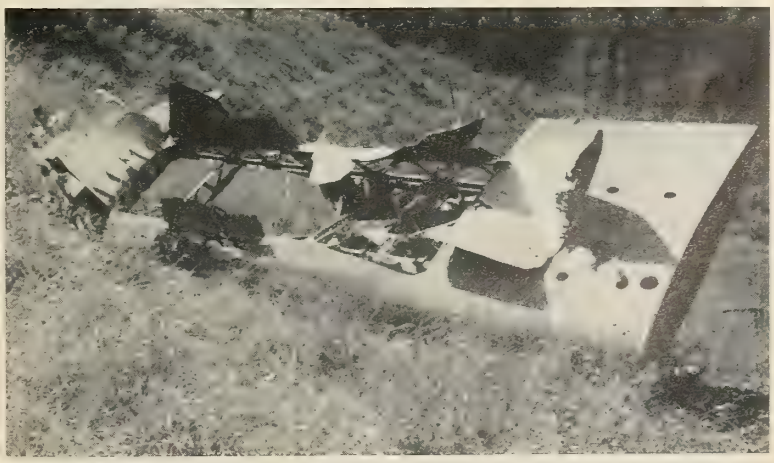
A pre-fire check-out can confirm reliability of the entire rocket load, over seventy, within a few minutes. The firing rate is as high as 1800 rpm or a maximum 1/15 sec. time interval for salvo pairs from twin pods.

Oerlikon has patented the trap device which releases exhaust gases briefly during firings and automatically closes to reduce aerodynamic drag. Contact pins are between the end of the launching tubes within a pod and the traps in the 31 rocket pod featured with the 8 cm. rocket.

This pod is suspended below the wings of an aircraft and the firing circuit has a intervalometer control which can be installed in the pylon or pod.

Oerlikon Machine Tool Works Buehrle & Co. has given its rocket weapons system notable prestige by conforming its techniques to USAF-type specifications as well as to particular needs outlined by its foreign buyers.

The company is quick to point out as well that, like Swiss watches and train schedules, there is little time loss between the pilot's reaction and rocket ignition. ⌗



*THIS ALL-METAL WING was selected as a target for a passing-attack test of an Oerlikon 8-cm folding fin rocket. The results are apparent.*

# soviet affairs

by Dr. ALBERT PARRY

### Giraffes as outer-space test animals

are now being used by Soviet space-medicine researchers. This is revealed by A. Klenov in the Moscow *Komsomolskaya Pravda* of December 2, in an article entitled "Astronauts, Get Ready! The Day Approaches . . ." The African mammal is chosen for acceleration tests because of his long neck, but not because—pardon the jest—the neck's length provides ample room for instrumentation during experimentation. The reason is explained by Klenov in these terms: When a man or any other animal is placed along a rocket's axis, and there is sudden acceleration, blood rushes either from his head to his feet or from his feet to his head, with equally bad and sometimes disastrous results for him. In particular, the man's (or any other animal's) heart cannot under such circumstances successfully pump the blood needed by his brain. But the giraffe's heart is naturally strong because it normally has to send blood all the long neck's way to his brain. Klenov writes: "It is as if the giraffe, although the earth is his habitat, were all the time flying in a rocket with acceleration." The object of the Soviet tests is most likely to discover how strong a heart-muscle system is needed by man before he can withstand his rocket acceleration as easily as does the giraffe.

### Swine and bears are other test animals

mentioned in the same article. These have been used in Soviet space-medicine laboratories because, "insofar as their biological 'resistance of materials' is concerned, their bone systems have proved to be close to the same system in human beings." The Russian author notes especially the pig's "neck part of the spine" and the bear's pelvis bone. (For much the same reason, bears have been used by our Air Force experimenters in acceleration and deceleration tests in New Mexico, but in fast rides on sled-tracks rather than in rockets or balloons.)

### The sea as a source of lithium

and other rare space-age metallic elements is envisaged for the Soviet in the near future by A. Davankov in his book *Volshebnyie Zerna* (Magic Seed), recently published by the Young Guard publishing house. The book is about ionites or "ion-exchanging tars," which according to the Russian writer are destined to play a remarkable role in man's economy when better technology of ionite exploitation is achieved. At one point in his book he describes a floating laboratory of tomorrow which, with hardly any crew or production staff (so complete will be its automation), will navigate the earth's seas and oceans to extract lithium among other space-age elements, all with the aid of ionites.

### Experiments resulting in artificial lightning

are being conducted in the Energetics Institute of the Soviet Academy of Sciences by Doctor Ilya S. Stekolnikov and his assistant Ye. N. Brago. The article by N. Dobrovitsky in the Moscow *Trud* for December 14, describing these experiments, emphasizes the peaceful nature of Doctor Stekolnikov's successful work: "He reveals the laws of development of electrical charges and thus facilitates opportunities for their better application in people's economy." The new experiments also contribute to a better understanding, as well as to further improvement, of man's fight against the harmful effects of natural lightning: "Magnetic registers of an original type, made of a special alloy, within several years recorded nearly 1000 thunderclaps. Thus were obtained basic characteristics of natural lightning, needed for estimates of anti-lightning shields." No mention can be found in the article of earlier suggestions that the Soviets were interested in artificial lightning as a war missile. (For previous discussion of Russian experimentation with ball lightning, see SOVIET AFFAIRS, April 1958, page 136, and June 1958, page 159. Also see the article "Reds May Use Lightning as Weapon" by Donald J. Ritchie in M/R for August 24, 1959, pages 13-14.)

## Langley Hydrodynamic Research Switched to Navy

THE NAVY HAS taken over and reactivated the hydrodynamic research facilities at Langley Field, Va., formerly operated by National Aeronautics and Space Administration. They will be operated as the high-speed phenomena division of the David Taylor Model Basin.

The newly established division will conduct research and development programs in high-speed craft and bodies such as hydrofoils, air cushion vehicles, hydro-skis, planing catamaran, STOL seaplanes, torpedoes, and underwater rocketry. Programs will be run for Navy's BuShips and BuWeps. Services will also be provided to NASA and private concerns.

Research programs scheduled include:

–Hydrofoils—Effects of impact, lift, drag and supercavitation; interference effects of foil flaps, etc.

–Ground-effect machines (Hydroskimmers)—Spray control, motion in waves up to fifty knots, ditching resistance, self-propulsion, etc.

–Development of 100-knot torpedo.

–Tests of underwater rocketry.

Tests will be conducted primarily in a large, indoor salt-water tank—2960 feet long, 24 feet wide, 12 feet in water depth—equipped with a wavemaker and a carriage capable of a speed of 50 knots.

The Navy will also have access to an outdoor fresh-water high-speed hydrodynamics facility (2180 x 8 x 5 feet) equipped with a carriage with a speed of 150 knots.

The Navy is responsible for the operation and maintenance of the facility, although the title to all buildings and equipment will be retained by NASA. The Division itself is physically located on property belonging to the Air Force.

## AEC Moves to End Housing Shortage at Los Alamos

FIVE PROPOSALS for construction of a large-scale housing area near Los Alamos Scientific Laboratory have been received by the Atomic Energy Commission, virtually assuring much-needed housing for scientists working on numerous missile, rocket and space projects.

The shortage of housing at the New Mexico laboratory had been causing problems in the *Rover* nuclear rocket and other programs. (M/R, Aug. 1, 1960, p. 11)

In what has been considered a long-overdue move, AEC will select one of the bidding developers and negotiate a contract locally.

## Harmonic Drive

(Continued from page 24)

friction characteristics of the drive. Thus, the drive is particularly well suited for tracking antenna and similar hardware in which, under certain operating conditions, the input speed is extremely low and output speed is almost indiscernible.

In the 40,000 to 1 drive, which is the largest transmission yet built, minimum backlash and high efficiency were also prime requirements. Estimates are that the Harmonic Drive principle is completely practical for ratios up to millions to one.

The unit shown in Fig. 5 is a good example. Developed for an airborne radar system, it is one of two Harmonic Drive transmissions that control the antenna position through a mechanical linkage.

Input to the drive is from a 10,000 rpm, 0.038 hp DC motor whose stall torque rating is on the order of 1 in.-lb. The stall torque from the transmission under these conditions is 85 in.-lbs., which is substantially greater than the capability of an equivalent-sized spur-gear unit. Its backlash is also considerably less: one minute or less, as compared with approximately 20 minutes for a spur gear drive. Because this unit was designed for missile application, light weight, compactness and reliability were parts of the specifications.

### Possible Design Variations

These are but a few of the transmissions that have been developed for military and missile applications. Others have been employed in commercial aircraft, such as the Boeing 707, and carried through the preliminary design stage for reducing the output from high-speed gas turbine engines for high-horsepower applications.

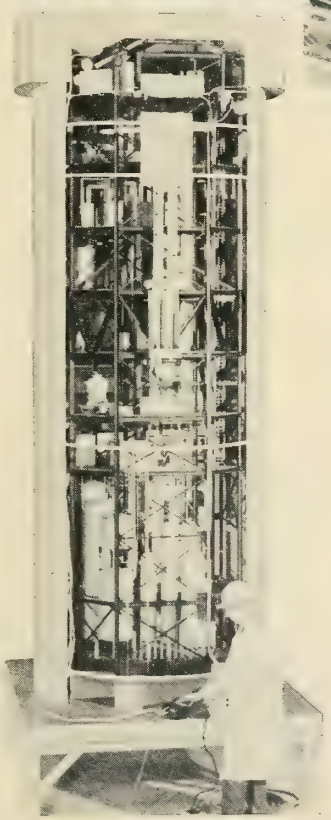
Another group is being used to transmit motion and power through the walls of vacuum apparatus, missile and space vehicles, and other sealed or encapsulated products. Still others have been developed for such products or apparatus as hoists, winches, machine tools, valves and positioning devices. In fact, about the only limitation developed to date is that in extremely small servo transmissions, such as those used for delicate motion transmission, inertia of the system may be higher than in conventional gearing.

The concept of transmitting motion through deflecting members is a completely new and heretofore neglected approach to the mechanical transmission of power or motion. It has already affected design and performance thinking in many missile and airborne systems, and is certain to have a far greater influence in the near future. ❖


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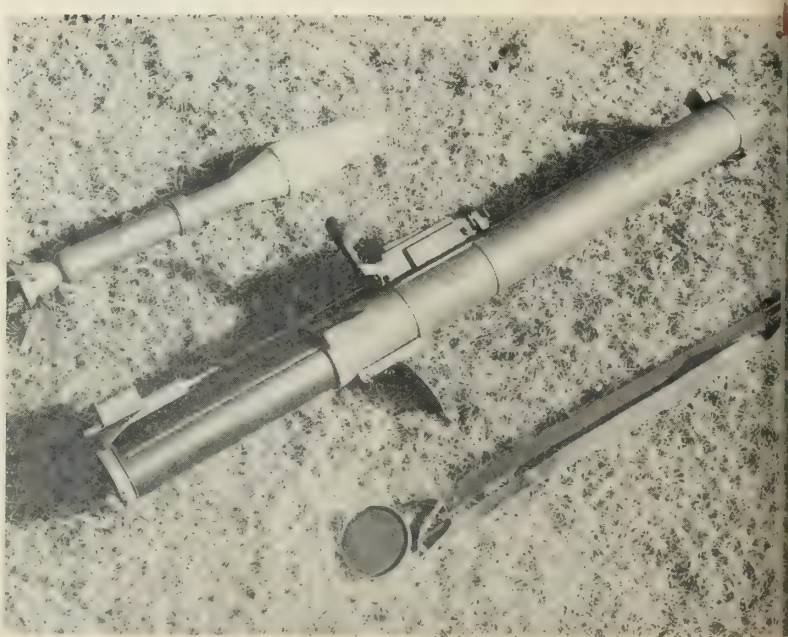
# G.I. to Get Easy Handling Tank Killer

*ARMY'S NEWEST ENTRY in the tactical weapons field is the one-man rocket grenade LAWman. The light anti-tank weapon can be shoulder-fired prone (above), standing or kneeling (below right). The missile is aimed through a rear peep sight and a graduated sight imprinted on a clear plastic rectangle at the mouth of the launcher.*

*The darker portion of launcher tube is telescopic and can be pulled out to convert the 25-inch carrying case to a disposable launcher. Magnesium fins folded against the motor case when packed (below) stabilize the rocket in flight.*

*Hesse-Eastern Division of Flightex Fabrics, Inc., is prime contractor for XM72 LAWman. Some 25 Army elements and industrial organizations were involved in the project, with Army Ordnance Missile Command acting as system manager.*





# Minuteman Equipment Well Integrated

***Inspection shows little variation in systems for mobile and hardened versions; a close look at how missile's G&C functions***

THE FIRST development engineering inspection (DEI) of the full-scale *Minuteman* ICBM system showed few differences in equipment between the mobile and hardened configurations.

Airborne portions of the two systems are practically identical. Just as in the case of the hardened sites, *Minuteman* trainborne operational equipment (TOE) design has been dictated by requirements of the missile's guidance and control (G&C) system.

Computer-controlled, the G&C system has two basic requirements—a program of operation and instructions when to act upon program portions.

The system meets these requirements by integrated operation of its major components: the G&C coupler; the missile targeting and control console; and the digital printer and tape perforator console.

One requirement not directly connected with the G&C system is re-entry vehicle fuzing. This information is supplied by the targeting and control console on special lines to the re-entry vehicle.

In the mobile *Minuteman* system the G&C coupler is the console electronically closest to the missile's G&C system. It couples all signals between missile G&C electronics and ground operational electronics.

• **Multiple chores** — Functionally, the G&C coupler will:

1. Transform all signals to the missile computer to a level acceptable to computer logic
2. Monitor all signals from the missile computer and, when necessary, transform these signals to a level acceptable to pertinent TOE logic
3. Transmit status information to various TOE units so state of system operation can be visually monitored
4. Synchronize operation of the computer and TOE by incorporating a precision clock
5. Act as a buffer between major system units to prevent ground loops.

• **Clock & back-up**—The precision clock provides signals for the coupler, the D17 missile computer, and the sequencer and monitor. The signals are available in sub-multiples of 1 mc to approximately 1 cps. Signals at about 4 kc are available for coupler use at phases of 0°, 90°, 180° and 270°.

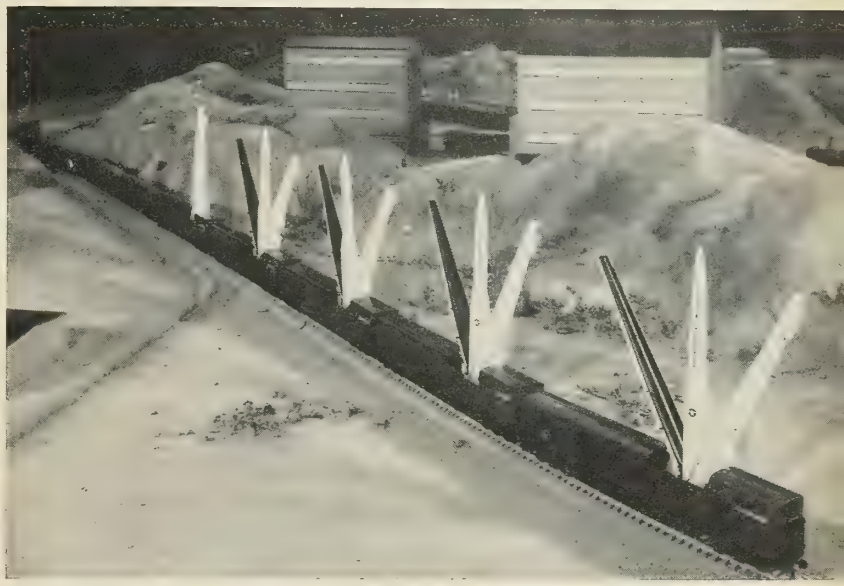
The clock's frequency generator is a 1-mc crystal-controlled oscillator accurate to 1 part per million. Its accuracy may be degraded to 10 parts per million after three years of operation. Associated with the oscillator is a serial counter which increases the period time from 1 sec. to 1.048576 sec.

A back-up oscillator is provided in case of failure. This standby unit generates a 15.6 kc signal with an accuracy degradation of not more than 5% over a three-year period.

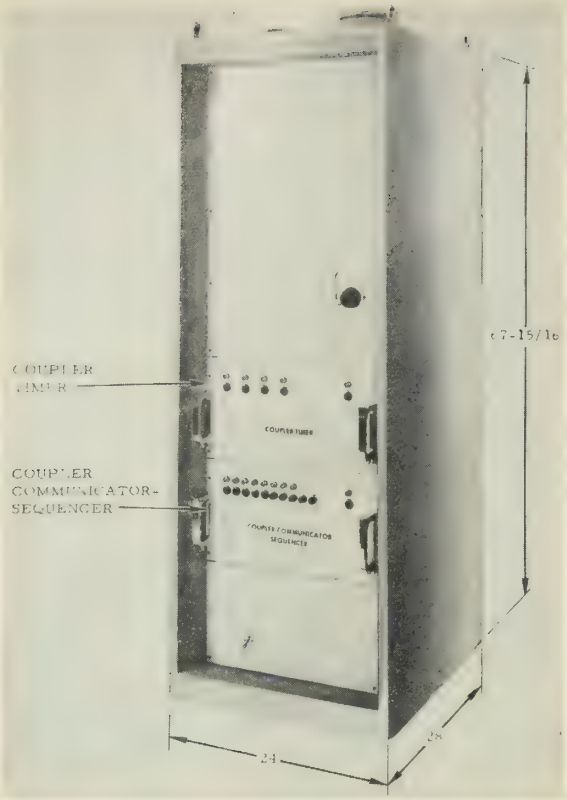
The precision clock provides the airborne missile computer with a clock pulse of 512$\mu$ sec. pulse width and a repetition rate of one pulse every 1.048576 sec. It also provides the sequencer and monitor with a symmetrical square wave at the same repetition rate.

• **Receiving commands**—A mode controller is included in the G&C coupler to receive discrete commands from the missile alinement set or from the sequencer and monitor. Commands are gated so the output will set up correct codes in the mode register. Mode controller outputs are sent to an encoder for use in coincidence checks. The mode register, through inputs for the controller, sets the G&C coupled in a particular state of operation. It also supplies a mode characteristic code to both the coincidence detector and output confirmer.

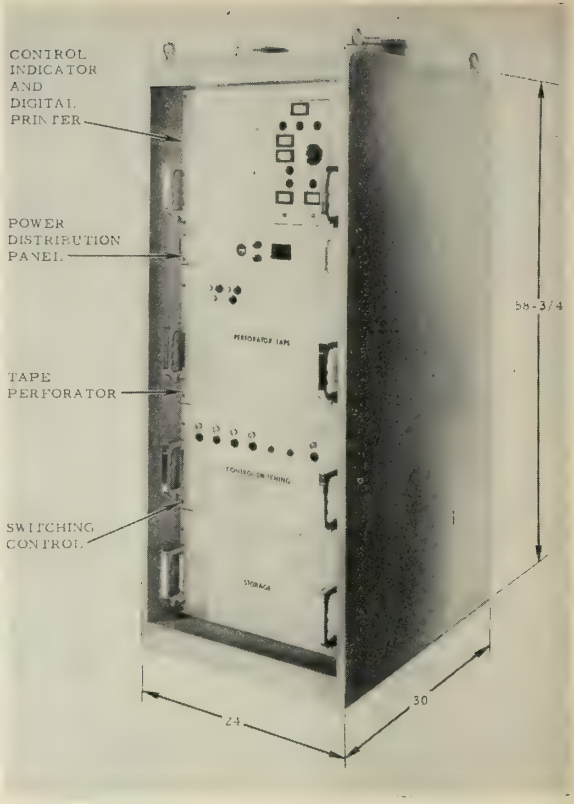
Discrete commands from the G&C coupler, azimuth alinement set, and the coupler's mode controller are received by the encoder. Following encoding, commands are sent to the coincidence detector via the computer in-



*MINUTEMAN TRAIN MODEL shows missile in "strategic alert" position, with strongback covers open. In actual operation, covers open seconds before launch.*




*MOBILE MINUTEMAN Trainborne Operational Equipment (TOE) includes guidance and control coupler console.*




*DIGITAL PRINTER and Tape Perforator console of mobile TOE selects and receives information from five G&C sets.*

formation receiver and used for checking coincidence between the input command and the resulting state of the mode register.

The computer information receiver provides pulse shaping and logic conversion of the computer output characters so they can be handled by the decoder and the coincidence detector, or by the targeting and control console.

Coded information from character output lines of the computer is received by the decoder and transformed into discrete outputs. Codes detected by the decoder are Sequence Advance, General Acknowledgement, Flight Mode Entered, Data Readout, Upstage No-Go, Downstage No-Go and G&C Alarm. No-Go and Alarm codes are sent to the error detector. Other codes are used to control the sequence timer and coincidence timer.

The coincidence detector verifies that the G&C coupler and the missile computer are in the same mode. Mode characteristic codes from the mode register in the G&C coupler are compared with mode confirming codes from the computer. A discrete output is issued to the coincidence timer if the codes are identical. The coincidence detector also verifies that the mode register is set properly before any command is issued to the missile computer. This is accomplished by comparing the input command from the decoder with the states of the mode characteristic from the mode register.

Controlled by the precision clock, the coincidence timer will, upon command, open a coincidence gate for 1.5 sec. If a coincidence signal is not received during this period, the error detector will detect a sequence error.

• **Timing provision**—During normal operation, several sequences require timing. This is accomplished by a sequence timer consisting of a counter and a diode matrix. The timer is set by a specific output signal from the output confirmer. At the end of the timed period, the sequence timer will expect a sequence advance from the decoder. If the advance is not noted at the proper time, the error detector will detect a sequence error. By this arrangement, coupler modes will be synchronized with computer modes.

The error detector recognizes Upstage No-Go, Downstage No-Go, Sequence Error and Coupler No-Go. It stores error information and sends discrete outputs to the output confirmer. When an error is detected, the coupler causes the computer to be reset and its discrete outputs to be disabled.

States of the mode register and error detector control the output confirmer. The latter sends system status information to the targeting and control console and the sequencer and monitor, indicating the status of the G&C coupler and missile computer. The output confirmer also issues the proper timing references to the sequence timer.

Computer discrete amplifiers receive character input codes from the tape programer of the console and transform the signal characteristics to a level acceptable to the computer.

• **Role of console**—A second major piece of the TOE system is the missile targeting and control console located electronically between the digital printer and tape perforator console and the G&C coupler. This console provides the following to the G&C system: (1) loading of the computer program; (2) manual control of the program; (3) visual monitoring of the program status; (4) electrical linking of the G&C coupler and the digital printer and tape perforator console; (5) furnishing fuzing instructions directly to the re-entry vehicle; and (6)

supplying power directly to the computer memory cold-storage write amplifiers when loading the program.

Basic sub-components of the targeting and control console are a tape programer, a control-indicator panel and four standard drawers of electronics.

Function of the tape programer is to transport and read out a punched mylar tape. It has capabilities of high-speed forward and reverse operation (slew) and, in conjunction with the tape programer controller, the capability of transporting tape up to and stopping at a predetermined code word on command (search). A photoelectric detector is used to read a standard eight-hole-per-frame tape. A ninth hole, the sprocket hole, is used to generate a timing pluse with every frame read.

The tape programer has a normal reading speed of 200 frames per second and a slewing speed of 600 frames per second. A single transverse column of eight code holes, plus one sprocket or timing hole, is read as a single word to produce five data bits, a timing bit and three steering bits.

There are two major parts of the tape programer controller which decode and gate tape programer output signals—a decoder and a tape controller.

The decoder operates separately on the five data bits and three steering bits read by the tape programer. The decoder gives 16 discrete outputs for the five data bits and eight discrete outputs for the steering bits.

The tape programer controller is sensitive to certain combinations of steering and data discretes, and thus controls the destination of information read from the tape. Certain combinations will send the resulting data bits to the missile computer; the fuzing mechanism; the digital printer and tape perforator console; the control-indicator panel of the targeting and control console; and, internally, in the latter console to execute and control other phases of the pre-punched program.

The tape controller combines signals from the decoder with manually initiated command signals to activate various modes of the tape programer. Manual tape control modes include Search-Forward and Reverse, and Slew-Forward and Reverse.

• **T&C panel**—Operating station for the targeting and control (T&C) console is the control-indicator panel from which the operator can control the console and, in turn, the computer program. The operator also is able to monitor G&C system status visually and continuously.

A coupler is associated with the panel to receive signals from the G&C coupler and tape programer controller, and to provide driving power to display these signals as status information.

The T&C console contains two command signal programers designated No. 1 and No. 2.

The No. 1 unit provides a controlled communications link between the G&C coupler and the digital printer and tape perforator. Four information channels are furnished: (1) tape output—input to this channel is from the tape programer; output may be switched to either the digital printer and tape perforator or to the missile computer via the G&C coupler; (2) Computer Output—inputs to this channel are character outputs of the missile computer; output is to the digital printer and tape perforator console; (3) Control—inputs are manually initiated command signals from the control-indicator panel; commands are sent to G&C coupler for program control; (4) Status—inputs are status signals from G&C coupler; outputs are to control-indicator panel coupler.

Command signals programer No. 2 provides a controlled link for decoded fuzing information between the tape programer and the re-entry vehicle. Fuze-setting process is monitored by verification signals from the re-entry vehicle received by the No. 2 programer. If verification signals are not received, a fuzing error is displayed on the control-indicator panel and the tape programer is stopped.

The No. 2 programer also contains the Enable Write power supply which is used when filling the missile computer from the tape programer.

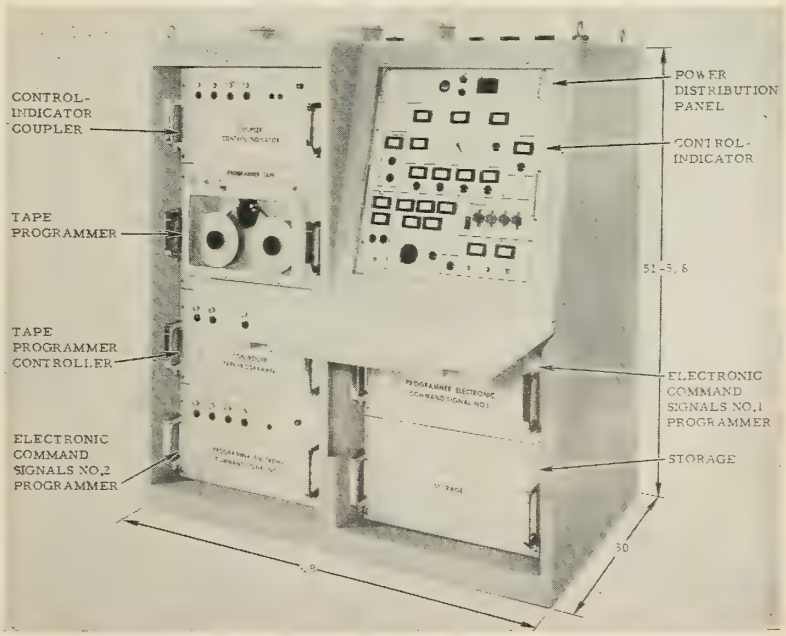
An error detector continuously checks the five data bits read from the tape for "odd-bit" parity. If a parity error is detected, the tape programer is stopped and a tape programer No-Go signal is displayed on the control-indicator panel. Odd parity of the five data bits is also checked at the decoder output. In this case, however, detection of parity error will stop the tape programer and transmit a console No-Go signal to the display panel.

The command car of the *Minuteman* mobile system will contain a third major component of the TOE—the digital printer and tape perforator console. With this unit, information can be selected and received from any one of five missile G&C sets.

The console consists of a tape perforator, a control-indicator panel and two drawers of electronics. It provides capabilities to: (1) print or punch on tape results of missile guidance set calibration upon command; (2) print results of missile velocity meter bias cycles upon command; and (3) print target azimuth angle and fuze-setting information from the targeting tape by the targeting and control console.

The control-indicator panel, like the targeting and control console layout, is the operating station from which the operator can monitor and control the console as well as select any one of five external system from which data may be received.

The digital printer provides auto-




*MISSILE TARGETING and Control Console in TOE system consists of a tape programer, a control-indicator panel and four standard drawers of electronics.*

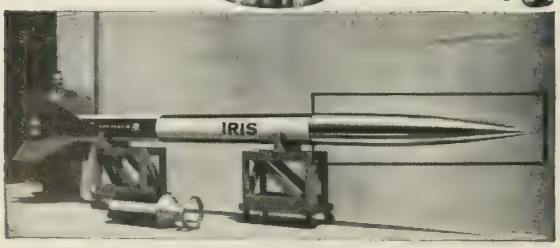
# Spincraft experience in space can mean down to earth savings for you...

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matic, high-speed, permanent recordings of data from an external system. It is capable of parallel entry and prints a line of 10 symbols simultaneously (alphabet or numeric), utilizing 13 columns of paper tape. One-line print out and paper advance will occur in 166 ms, giving a print speed of six lines per second.

The tape perforator portion of the console is capable of punching a complete line, composed of eight code holes and a sprocket hold, selecting a code hole and advancing the tape in 40 ms. It can also continuously punch a minimum of 20 characters per second. The perforator receives characters from its own electronics section which receives character inputs from the missile targeting and control console. Characters to be punched are stored during each punch cycle. When they are punched, memory devices are reset.

Incorporated in the console is a sequencer (binary counter) which receives timing pulses and counts to 10 during normal operations—to 18 during self-test.

A decoder unit decodes the first and last characters of each information word received. It also converts binary coded decimal outputs from the sequencer to decimal discretes from 2 to 10. The discretes channel the character of the information word to their designated places within a register.

The register is a memory device that stores the data word to be printed. It handles two types—an information word or a computer error word.

An odd-parity check is made of all character inputs to the digital printer and tape perforator console. A parity error lamp will light on the control-indicator panel if such an error occurs.

Final unit of the TOE is the DC portable power supply which provides overvoltage to the missile for starting the G&C set, gyros, fan and memory disc. The set consists of a rechargeable battery pack, a voltage divider and a recharging circuit. Upon command from the sequence and monitor console the unit puts out 40 to 45 volts DC for 2 to 2.5 seconds, after which a second command terminates the voltage. The DC package is capable of 10 cycles over a 10-day period without recharging, and 10 recharging cycles before replacement of the battery pack.

Guidance and control test equipment is nearly all automatic and is quite similar to that of the silo-based *Minuteman* system. It provides Go, No-Go information which, in conjunction with the programing test set and the ground electronic test group, performs system tests at overall and/or subsystem level. ⌗

# Army Readies Huge Test Building

THE ARMY WILL be able to subject entire missiles to global environments with the completion of a $3-million-plus Preflight Building at Redstone Arsenal, Huntsville, Ala. early next spring.

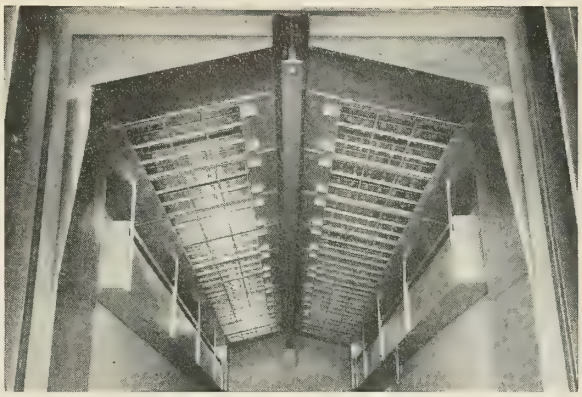
The facilities are part of the Army Rocket and Guided Missile Agency's Test and Evaluation Laboratory. Specimen chambers are available for high and low temperatures, temperature shock, humidity, salt spray, vibration, fungus resistance, sunshine, rain, and sand and dust tests. The chambers are constructed in accordance with Mil-E-5272C.

This specification establishes generally applicable procedures for testing aeronautical and associated equipment under simulated and accelerated climatic and environmental conditions.

Each of the major test cells opens to a track-mounted crane assembly. Overhead hoist beams in each of the cells allow a complete missile or other test specimen to enter and withdraw swiftly. The only exception is the sand and dust chamber, where the specimen is mounted on the chamber door and then swung into the cell as the door closes.

The test area has heavily reinforced walls with blowout roofs and doors on each of the chambers. Thus the facility can accommodate hazardous items.

Designed by Ralph M. Parsons, Los Angeles, and constructed by Pierce & Gresham, Decatur, Ala., the building is already staffed and in limited use.



*SUNSHINE CHAMBER subjects missiles to radiant energy generated by these banks of lamps. The stainless-lined cell can handle a 35-ft. weapon.*

The prime equipment contractor is Technical Constructors, of Dallas.

• **Varied environment**—A 25,000-force pound electromagnetic shaker with a frequency range of 5 to 2000 cps is mounted in the main vibration cell. In addition, the Preflight Building will house five other shakers of various sizes in the two vibration cells. Both cells will have temperature controls.

Missiles up to 30 ft. in length and 8 ft. in diameter can be subjected to rain and salt spray tests in another cell. The rain rate can be varied from 4 to 12 in. per hour with variations in direction up to 45°.

The facility has a sunshine cell capable of flooding a 35-ft. missile with radiant energy at the rate of 100 to 140 watts per square foot while maintaining the temperature at 113°F.

Six simultaneous static or dynamic loads up to 100,000 lbs., either in tension or compression, can be applied to specimens as large as 60 x 72 x 240 in. and weighing 40,000 lbs. in the multi-component structural test chamber.

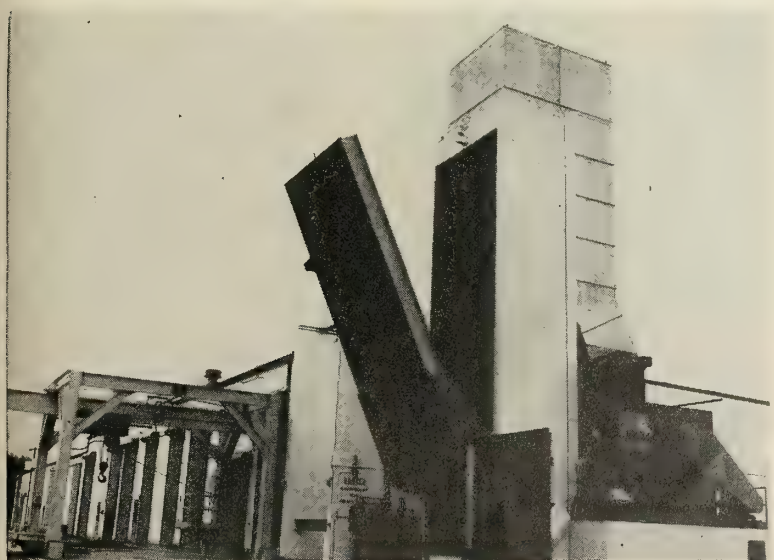
Two cells house X-ray equipment. A 150,000-volt system is currently available for inspections and a 22-million volt Betatron is planned. Cobalt 60 gammagraph equipment is available, along with ultrasonic, magnetic particle and dye penetrant systems.

Test items up to 24 feet in length and 5.5 ft. diameter will fit in the sand and dust chamber. Wind velocities from 200 to 2300 ft./min. are possible. Sand and dust size and concentration can be varied from 1 to 1500 microns and from 0.0001 to 1.0 grams/cu. ft.

Smaller cells simulate altitudes up to 100,000 ft. Other, similar sized chambers handle shock tests, accelerated and long-term storage tests. A 5400-gal. immersion tank is available.

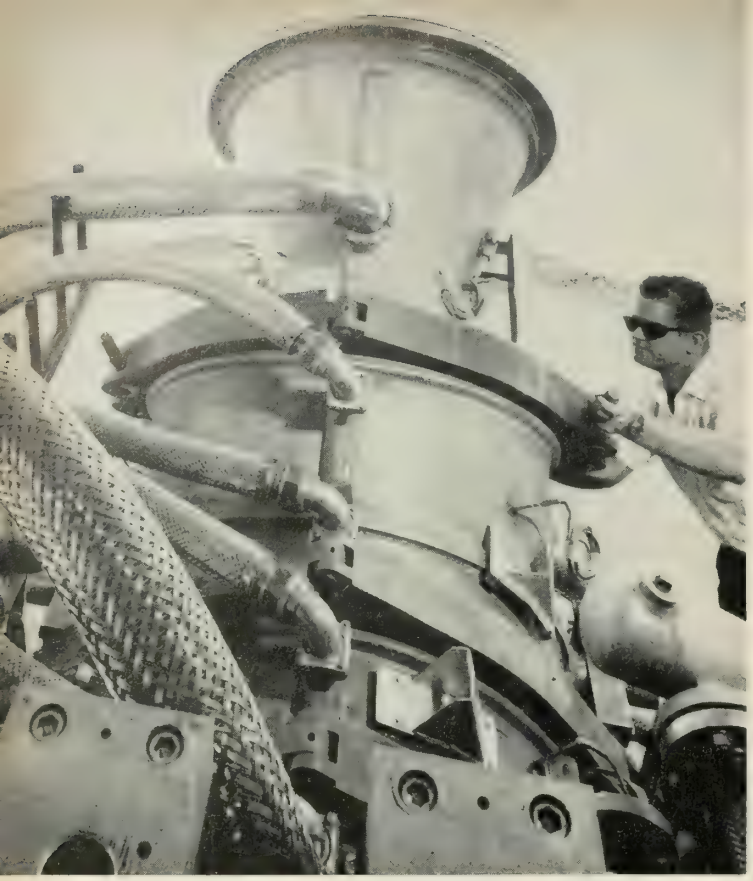
Physical measurement facilities are included in the Preflight Building and future plans envision a remote controlled drop test, a sustained acceleration test and an acoustic noise test.

The Preflight Building is the newest of the complex of test facilities operated by ARGMA and will be available for use by any government agency or contractor for tests associated with development of missile systems or system components. ⌗



*TEST ITEMS ARE MOUNTED on the sand and dust cell door, then swung into the chamber. Specimen loading crane has access to each cell along side of building.*

# Tory IIA Ge

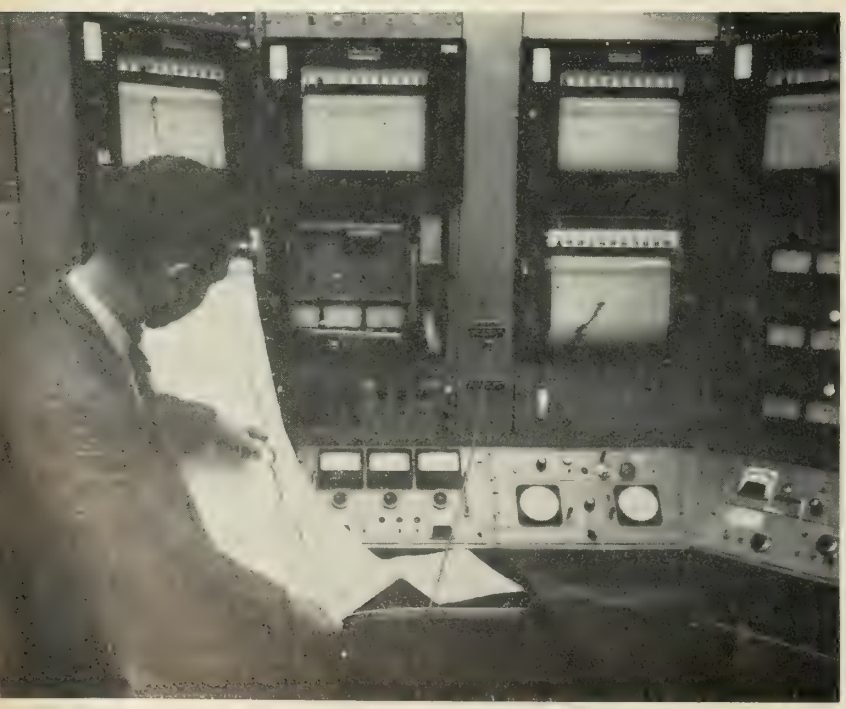


*TORY 88A TEST TRACK is nicknamed "Jackass and Western Railroad."*

TESTS TO BRING the Tory IIA-1 reactor up to full power are now in progress at the AEC's Lawrence Radiation Laboratory at Jackass Flats, Nev. The reactor, being designed for the Air Force-AEC *Pluto* nuclear ramjet, went critical for the first time on Dec. 9. Full power design is about 150 thermal megawatts. The reactor is expected to produce about 5000 to 10,000 lbs. thrust, although program scientists are not attempting now to reach these levels. The reactor unit shown here is backed up by Tory IIA-2. The core for the second unit is being produced by Atomics International.

No military requirements as yet exists for *Pluto*. But the ramjet is the most likely one to power a supersonic low-altitude missile—SLAM—should this be decided upon as the best method of getting in under enemy radar defenses.

*Photos by Aerojet-General and Frank G. McGuire*



*DATA IS RECORDED during a cold-flow run of the test unit.*

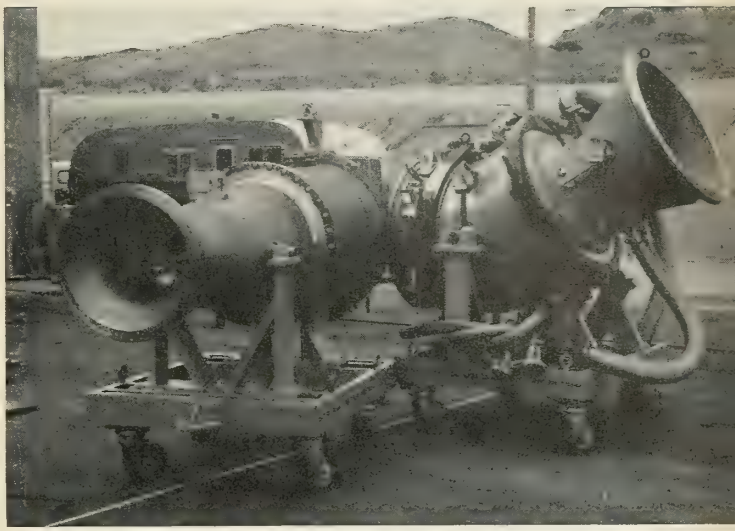


*COOLING LINES give the reacto*

# ests Aimed at Full-power Operation

At present progress levels, it is believed a flying version of a *Pluto* ramjet vehicle could be produced by 1965. The Mach 3 vehicle would be capable of sustained flight for three days. Cruising over ocean or desert, it could be directed to a pre-selected target on command. The unmanned bird would have a large payload capacity—perhaps up to one-quarter of gross weight. Thus it could carry a 20-megaton or bigger warhead. Operating altitude of such a missile would be at a relatively constant 1000 ft. or other low level.

Core (lower right) contains fuel elements of enriched uranium and beryllium oxide. There are more than 100,000 elements in the core measuring 30 inch by 45 inch. Nickel alloy tension rods are mounted between interstices, providing longitudinal support and medium for water coolant.



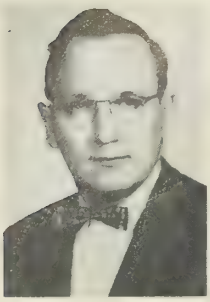
*SPARE NOZZLES for test unit sit outside the assembly building.*

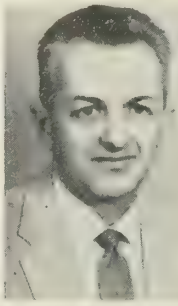


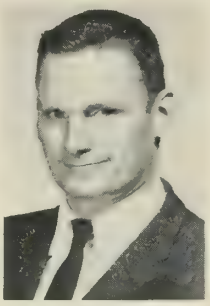
*earance of an old-time fire engine.*



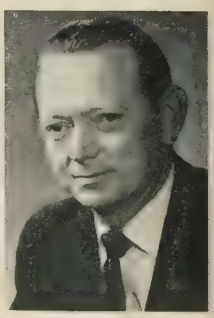
*CORE HAS MORE than 100,000 uranium and beryllium oxide fuel elements.*


TITUS


HENNESSY


INTO


GILLETTE


HOGAN

**David W. Pertschuk:** Appointed Director of Reliability and Quality Control at the Precision Products Dept. of Nortronics. Prior to joining the firm, he was responsible for all reliability activities and procedures at Arma Division, American Bosch Arma Corp.

**Lee Hennessy:** Former market research and development engineer for Rogers Corp., joins Industrial Electronic Rubber Co. as technical director responsible for management of the materials development and material quality control.

**Theodore E. Borque:** Joins Consolidated Diesel Electric Corp. as senior project engineer directing design and development of new types of gas turbine-powered ground support equipment for aircraft and missiles. Was formerly a project design engineer with General Electric Co.

**Ted Candee:** Former staff assistant, named manager of the Procurement and Contracts Division of the California Institute of Technology's Jet Propulsion Laboratory.

**M. A. Benanti:** Joins Precision Circuits, Inc. as an electronic engineer, with responsibility for extending the Molecular Electronics line of semiconductor test equipment.

**Charles K. Titus:** Former director of the digital computer laboratory at the Air Arm Division of Westinghouse Electric, joins the staff of the Communication and Data Processing Division of Collins Radio Co. as manager of the scientific analysis and programing department.

**Kendell Oulie:** Former assistant to the director of planning named director of planning for The Garrett Corp., replacing **John W. Calvert,** now manager of marketing services.

**A. Norman Into, Jr.:** Formerly marketing manager, Communication and Navigation Equipment in RCA's Airborne Systems Division, joins Rese Engineering, Inc. as director of marketing.

**Pierre A. Portmann:** Promoted to the office of assistant director in the Research and Development Directorate of Page Communications Engineers, Inc. Was formerly senior staff engineer in the R&D Directorate.

**James L. Fouch:** Former general manager of Microsound, Inc., named executive vice president of Calibration Standards Corporation.

**Jack Gillette:** Appointed associate director of engineering for Standard Rectifier Corp. Was formerly chief electronics engineer for Hughes Aircraft Co.'s Semiconductor Division.

**Orien L. Hogan:** Former chief of applications engineering, appointed senior representative at Huntsville for Rocketdyne, a division of North American Aviation, Inc., replacing **D. H. Stewart.**

**Phillip V. Aronson:** Named sales manager for The Raytheon Co.'s Airborne Products, Submarine Signal Operations.

**Michael J. Marino:** Former advertising manager, named marketing manager of International Resistance Co.'s Major Industrial Distributor program.

**Richard J. Stone:** Former projects leader in the Research Division of the Curtiss-Wright Corp., joins Corning Glass Works as research and development supervisor in the delay line section.

**Frank H. Bower:** Appointed to the newly-created post of manager of research and development contracts for the Semiconductor Div. of Sylvania Electric Products, Inc.

**R. L. Bentley** and **R. P. Conniff:** Appointed assistant to the vice president of marketing and manager, re-entry vehicle sales, respectively, for Avco Corp.'s Research and Advanced Development Division.

**George E. Spaulding, Jr.:** Former director of research and general manager of the SPARD division of Electric Autolite Co., joins Bell & Howell Co.'s Photo Products Division as vice-president in charge of engineering operations.

**Howard P. Mason:** Former corporate base manager at the Pacific Missile Range for Aerojet-General Corp., named manager of the company's Washington, D.C., office.

**William M. Prull** (USAF-ret.) Joins the Advanced Systems Research Dept., Military Systems Division of Lockheed Electronics Co. as an operations analyst.

**Andrew J. Myers:** Former quality manager for the Boeing Airplane Co., joins The Martin Co.'s Denver Division as manager of Quality Control Fabrication.

**Rubin Blumkin:** Elected vice-president, engineering, at General Restance, Inc. was formerly chief engineer.

**C. F. Pizac:** Former manager-sales, named director of marketing for the Electronics and Avionics Div. of The Emerson Electric Mfg. Co.

**George M. Cooley** and **Ronald D. Curtis:** Appointed senior analytical engineer and senior project engineer, respectively, for The Fafnir Bearing Co. Cooley, prior to joining the firm in 1956, was a research engineer with United Aircraft Corp.; Curtis came to Fafnir in 1956 from the Bristol Machine Co., where he was a designer and project engineer.

**W. A. Smith:** Manager of new product sales for B. F. Goodrich Industrial Products Div., named manager, marine and ground support equipment, for B. F. Goodrich Aviation Products.

**Denham Scott:** Assistant to the president, The Garrett Corp., appointed an associate member of the Military Procurement Advisory Committee to the U.S. Senate.

# contracts

## NASA

$216,210—**Electronic Associates, Inc.**, Long Branch, N.J., for centrifuge conversion computer.

$75,000—**Ryan Aeronautical Corp.**, San Diego, for development of methods and techniques for high-energy forming of hemispherical and cylindrical shapes involved with space exploration programs.

## NAVY

**Laboratory For Electronics, Inc.**, Boston, for design, documentation and prototype production of analog computer modules for use in *Polaris* submarines. Subcontract from **General Electric Co.'s Ordnance Dept.**

$8,300,000—**Westinghouse Electric Corp.**, Pittsburgh, for additional production of the radar portion of the air missile control system for the F4H-1 fighter plane.

$4,941,573—**Lockheed Aircraft Co.**, Burbank, Calif., for installing Julie-Jezebel detection equipment on 69 Neptune antisubmarine aircraft.

$2,500,000—**Raytheon Co.**, Waltham, Mass., for continuation of industrial support to MIT in design and development of the *Polaris* inertial guidance system.

$110,000—**The Siegler Corp.**, Hufford Div., El Segundo, Calif., for ground support equipment components for the *Terrier* antiaircraft missile.

## MISCELLANEOUS

**Jet Propulsion Laboratory** has awarded study contracts to investigate the feasibility of building an advanced space tracking antenna 200 to 250 ft. in diameter to: **Blaw-Knox Equipment Div.**, Pittsburgh; **Hughes Aircraft Co.'s Ground Systems**, Fullerton, Calif.; **North American Aviation, Inc.**, Columbus, Ohio; and **Westinghouse Electric Corp.**, Pittsburgh. Amounts not disclosed.

## AIR FORCE

**Cohu Electronics, Inc., Kin Tel Div.**, San Diego, for an undisclosed amount to supply closed-circuit television systems to be mounted in *Atlas* launch complexes at Vandenberg, Offutt, Warren and Fairchild AFB's.

**RCA**, a "multi-million dollar" contract for the development of a complete communication subsystem for the *Dyna-Soar* test program.

**Espey Mfg. & Electronics Corp., Saratoga Industries Div.**, Saratoga Springs, N.Y., for 18 battery charger power supply units to be used to operate the underground *Titan* launching system in event of electric power failure. Subcontract from **The Martin Co.**

**Foto-Video Electronics, Inc.**, Cedar Grove, N.J., for production of a closed-circuit color television system. Amount not disclosed.

**Chance Vought Corp.'s Astronautics Div.**, Dallas, for developing the nose cap for the *Dyna-Soar* man-carrying space vehicle. Amount not disclosed.

$3,210,874—**Eclipse-Pioneer Div., The Bendix Corp.**, Teterboro, N.J., for aerno compensators, converters and computers, spare parts, ground support equipment and data.

$2,000,000—**Minneapolis-Honeywell Regulator Co.**, for design, development and production of flight control electronics for the *Dyna-Soar*. This is in addition to a previous $2,700,000 for development of an inertial guidance system.

$379,205—**Boeing Airplane Co.**, Seattle, for technical data applicable to the *IM-99* missile. (Six contracts.)

$277,433—**General Dynamics Corp.'s Convair-Astronautics**, San Diego, for emergency sub-chassis for Azusa Mark II.

$200,000—**General Atronics Corp.**, Philadelphia, for research and development studies.

$147,803—**Douglas Aircraft Co.**, for study of exhaust heat trails by rockets launched from Cape Canaveral over the Atlantic Missile Range.

$140,000—**Ford Motor Co.'s Aeronutronic Div.**, Newport Beach, Calif., for investigating semirigid and nonrigid space structures for use at extreme altitudes.

## ARMY

$28,695,115—**Hardaway Contracting Co., Oman Construction Co., R. P. Farnsworth & Co. Inc., Wright Contracting Co.**, a joint venture trading as **Midland Constructors**, Columbus, Ohio, for construction of missile launch facilities, *Titan II*, Phase 1, near Little Rock AFB.

$20,000,000—**Eclipse-Pioneer Div., The Bendix Corp.**, Teterboro, for continued manufacture of the inertial guidance system for the *Pershing*. Subcontract from **The Martin Co.**

$5,944,577—**Northrop Corp.'s Radioplane Div.**, Van Nuys, Calif., for production of 770 *RP-76* rocket-powered target missiles.

$2,072,000—**Zarpas-Fullerton**, Pittsburgh, for construction of *Bomarc* facilities at McGuire AFB.

$1,740,170—**R. E. Clarson, Inc.**, St. Petersburg, Fla., for construction of precision trajectory measurement system, Patrick AFB.

$1,274,983—**Land-Air, Inc.**, Chicago, for research and development on range instrumentation at White Sands Missile Range.

$900,000—**Sylvania Electric Products, Inc.'s Electronic Defense Laboratories**, Mountain View, Calif., for development and rapid fabrication of a prototype electronic warfare system.

$3,000,000—**Ford Motor Co.**, Newport Beach, for design and development of combat vehicle weapon system.

$848,690—**Western Electric Co.**, New York City, for research and development of *Nike-Zeus*.

$435,000—**Gulton Industries, Inc.**, Metuchen, N.J., for supplying analog to digital converter systems for use in the *Sergeant* program.



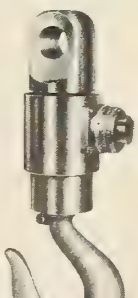


**READS DIRECTLY IN POUNDS NO CIRCUIT BALANCING. NO CHARTS. CHOICE OF TENSILE COMPRESSION OR PUSH-PULL.**

Designed upon differential transformer principle. Has no internal gears, levers or linkage to bind or wear.

Dillon Load Cells are accurate to within ½ of 1% of full capacity at any point on dial. Non-magnetic. Sensitive to load change of 1/10th of 1% of scale capacity. Tare loads up to 30% can be quickly canceled. Linear dial spacing made possible due to fact that output from Load Cell is in exact linear relation to mechanical displacement.

12 volt DC battery operated model or straight AC model optional. As many as four Load Cells may be used with one Indicator which totalizes individual loads. Minute elongation of Load Cell, even when operating at peak, varies between .002" and .004" depending upon capacity.



Load Cells are fully sealed. Most capacities are of beryllium copper. Can't rust or corrode. Explosion-proof versions can be supplied on order. AN type sockets and plugs used throughout with heavy duty cable.

Temperature compensated circuit utilizes semiconductors entirely. No tubes. No complicated, troublesome amplifiers. Load Cell safety factor is 4-1. Hysteresis is less than 1/10th of 1% of full scale capacity. Recorder jack is standard.

**27 DIFFERENT CAPACITIES** from as low as 0-150 pounds up to as high as 0-200,000 pounds. Variety of connectors such as swivel hooks, cable sockets, threaded studs, etc., available as accessories.

COSTS YOU NOTHING TO INVESTIGATE. WRITE TODAY FOR PROFUSELY ILLUSTRATED BROCHURE. LC-2

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VAN NUYS 31, CALIF.

Circle No. 12 on Subscriber Service Card.



## Miniature Triggered Spark Gap

A miniature triggered spark gap capable of switching 18 joules of energy at 3000 volts, by remote control, has been developed by the General Electric Power Tube Dept.

The Z-5362 is a gaseous, cold cathode switch tube requiring no warm-up time. When suitably "potted," the brazed ceramic tube can withstand shock of several thousand g's for several milliseconds. It has no delicate parts and can be soldered or welded into a circuit. Operation is unaffected by temperatures from –80 to 200°F

Although it is primarily designed for "one-shot" applications, the tube can be tested both before and after installation, without destroying it.

Circle No. 225 on Subscriber Service Card.

## Filaments and Boats

A complete line of tungsten, tantalum and molybdenum filaments and boats are now available in a variety of sizes and shapes from Allen-Jones, Inc. Manufactured for use in high vacuum as an evaporation source, these filaments and boats are stress relieved to obtain the longest possible life in operation, and to maintain their geometry during use.

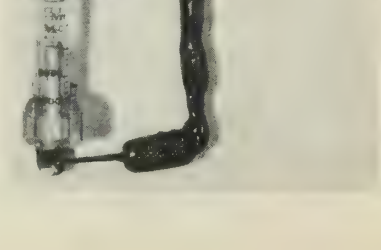
Circle No. 226 on Subscriber Service Card.

## Elapsed Time Indicator

An elapsed time indicator—the MINICHRON—the smallest known indicator of elapsed time, is available from Sela Electronics Co. Its features include no moving parts and infinitestimal current consumption, which makes the miniature unit especially attractive for use with compact and semiconductor circuits.

The MINICHRON is available in voltages of 12 or 115 DC, and 115 AC, with time increments totaling 100, 1000, 5000 or 10,000 hours.

Circle No. 227 on Subscriber Service Card.



## High Temperature Oven

A unique Laboratory Furnace introduced by Shampaine Scientific Co. features faster heat up time and greater economy due to addition of recently developed high temperature insulation.

Crystalline properties of new insulation used permit reflection of more than 90% of exposed radiant heat—delivers greater insulating properties than 5-8 in. of conventional firebrick. Reduced size of insulating factor allows increased hot chamber volume in smaller, more compact furnaces.

Heat up time from ambient to 1600° F is 30 minutes or less. Shampaine's new furnace is designed to operate on 50% less wattage than existing furnaces for greater operational economy.

Circle No. 228 on Subscriber Service Card.

## Thermocouple Voltmeter

Thermocouples as long as 10,000 feet may be used for temperature indication and control with an all-transistorized instrument announced by Metronix, Inc.

Model 600 is a panel-mounting dc electronic voltmeter especially suitable for monitoring temperatures. It operates on signals that become too small to actuate an ordinary pyrometer after they encounter the resistance of extremely long thermocouples. Designed for circuits requiring high resistance measurements, Model 600 has an input resistance of at least 100,000 ohms —or 2000 times the resistance of an ordinary pyrometer. The signals that actuate the instrument are so small—around half of one ten-millionth of an ampere—that they do not add load to the circuit. The signals are then amplified by the instrument into useful form.

Circle No. 229 on Subscriber Service Card.

## Accurate Time Generator

An all-electric digital time generator for system control and synchronization, or for time correlation among diverse data acquisition and logging devices is available from the Information Technology Division of Lockheed Electronics Co. The instrument employs a 1-kc tuning-fork oscillator to assure time-base accuracy of 5 parts in 100,000 for any clocked interval.

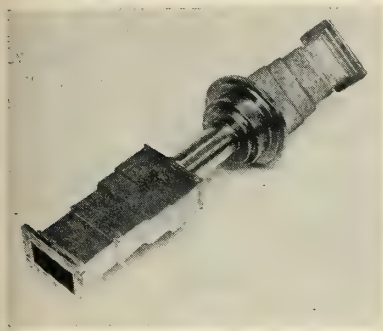
Model 320 yields two sets of outputs. The basic pulse frequency of the tuning-fork oscillator provides timing markers at 0.001-second intervals and, by means of transistor flip-flop dividers, every 0.01, 0.1 and 1 second as well.

Decimal outputs to a total of 23 hours, 59 minutes, 59 seconds are also provided at a rear-panel connector, and are simultaneously displayed on an array of six in-line glow-tube decimal indicators (Nixies).

Circle No. 230 on Subscriber Service Card.

## Microwave Rotary Joint

Canoga Corp. offers a high power waveguide Model RJSL-2A of the in-line variety incorporating transitions on each end to convert the TELO mode in the waveguide to the TEM mode in a coaxial line. Non-contacting coaxial



choke joints and ball bearings permit high speed rotation. An O-ring type of pressurizing seal is employed. Operates in a frequency range of 1700 to 1850 mc; VSWR 1.1; power handling capacity 5 megawatts peak, 35 kilowatts average; VSWR WOW .02; insertion loss .02 dbl flanges UG-435A/U.

Circle No. 231 on Subscriber Service Card.

## Digital Data System

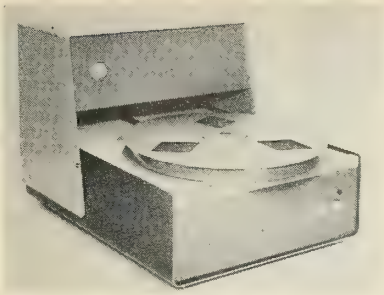
The Communications and Control Corp. has available a digital data system. The 1610 is designed to acquire data at high speed and accuracy with maximal reliability, only solid-state elements such as transistors and diodes are utilized. Accuracies of better than 0.1% are obtainable for periods up to six months without maintenance or calibration. Input analog signals representing pressures, temperatures, voltages, and displacements are digitized and a magnetic tape prepared on-line at a rate of 5000 readings per second or higher. Any number of channels can be prepared in increments of ten channels.

Circle No. 232 on Subscriber Service Card.

## Automatic Tape Degausser

An automatic Tape degausser capable of erasing reeled tape to a nominal 90 db below saturation level is available from the DataTape Division of Consolidated Electrodynamics Corp.

Performance of the Type TD-2903 was determined by erasing a pre-recorded 15-kc saturated signal and



playing back the residual signal through a filter having a pass band of ±30 cps.

The instrument will accommodate tape widths from ¼-2 in. television tapes on reels from 7 to 14 in. diameter. Both CEC and NARTB reel-hubs may be used. CEC hub adapters are available for use with reels having other dimensions.

Circle No. 233 on Subscriber Service Card.

## Lightweight VHF Antenna

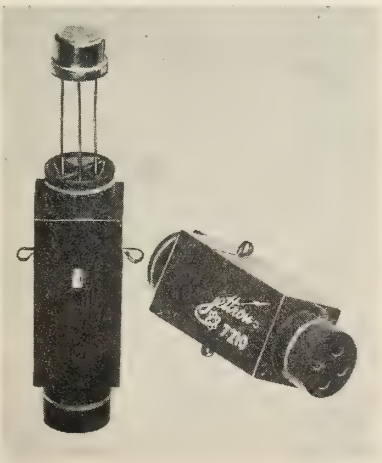
A lightweight, low cost air transportable and dual polarized VHF tracking and telemetry antenna, designed for immediate use in missile tracking applications, is available from Avien, Inc.

The VHF tracking and telemetry antenna is known as 420A, and is part of the Series 420 line of antennas. Air transportable, the 420A is lighter, smaller and less expensive than conventional array types of antennas currently in use for missile tracking operations. In addition to providing these advantages, the 420A operates in the standard frequency range of 215-260 mc with a gain of 18 db min. over the band.

Circle No. 234 on Subscriber Service Card.

## Transistor Test Socket

A socket for the production testing of 3 or 4 lead transistors is available from Jettron Products Inc. Designed



for 1/8 in. panel mounting in keyed hole and retained by a snap ring, sockets may be mounted on 0.812 in. centers. Double fingered spring contacts grip leads close to base of transistor with frictional force in excess of 50 grams on 0.017 in. diameter lead wires.

Circle No. 235 on Subscriber Service Card.

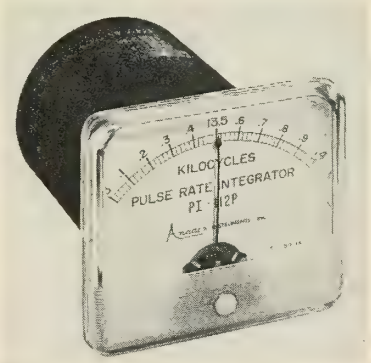
## Low Inductance Capacitor

Axel Electronics is marketing a low inductance capacitor. The unit is identified as 50E104 with a capacitance value of 1.0 mfd. and a voltage rating of 50KV. The capacitor has an internal inductance of 15 millimicrohenries and a ringing frequency of 1.3 megacycles. The capacitor is designed for 100% voltage reversal at 50KV and a life of 10,000 shots minimum. The unit features multi high voltage studs which allows for the use of multi gaps or transmission lines for low external inductance.

Circle No. 236 on Subscriber Service Card.

## Pulse Rate Integrator

A meter for measuring frequency deviation is available from Anadex Instruments, Inc.



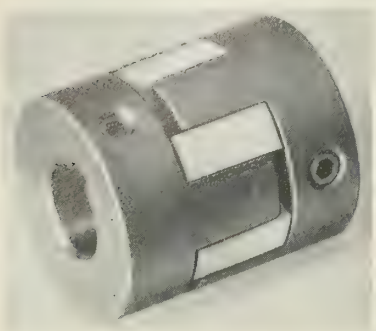

The Series PI-111 Pulse Rate Integrator features an input sensitivity as low as 10 mv rms. Standard models are available to indicate 57 to 63 cps and 380 to 400 cps. Variations are also available with center frequencies from 50 cps to 50 KC. All models feature extreme accuracy, reliability, readability, and 0.1% resolution, states the manufacturer.

Circle No. 237 on Subscriber Service Card.

## Flexible Couplings

Stainless Steel and glass-filled du Pont Teflon have been combined to provide a chemical-resistant flexible coupling from Eco Engineering Co. for pumps handling corrosive media.

Serrated coupling halves are precision stainless steel castings. Shock-



cushioning, self-lubricating spider is precision-molded from glass-filled Teflon, which obviates need for external lubrication and also acts as an electronic barrier, preventing the passage of stray currents between driver and pump.

Circle No. 238 on Subscriber Service Card.

## Digital Pressure Transducers

Continuous, accurate and reliable monitoring of gas and liquid pipe lines through printed records and warning alarms is possible with a series of digital pressure transducers available from Datex Corp.

Called the DX-100 Series, they indicate in digital form the magnitude of pressure inputs. The output of any transducer is suitable for entry into recording devices such as printers, card punches, tape punches, and light banks.

A typical unit contains an input pressure element, force amplifier, shaft position encoder, motor, power supply, mechanical linkages and terminal strips for electrical connections.

Circle No. 239 on Subscriber Service Card.

## Flow Rate Comparator

Simmonds Precision Products, Inc. is marketing a flow rate comparator of laboratory standard quality. Highly precise and accurate, this instrument is designed to compare, calibrate and check accuracy of liquid flowmeters including orifice, rotameter and turbine types. Designed to work with a range of liquid flow rates from 0-800 lb/hr, the basic unit requires an external electronic counter for a time-readout device. The flow rate comparator can be used without removing a flowmeter from its installation.

Circle No. 240 on Subscriber Service Card.

## Static Flip-Flop Module

Computer Control Co. is marketing a one megacycle, MIL-T-Series of plug-in digital modules.

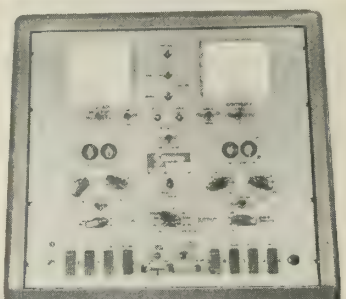
The Model FS-20 operates within a temperature range of 0° C. to 65° C. This exceeds MIL-E-16400, Class 4. It has a humidity maximum of 95% and fulfills MIL-T-17113 requirements for shock and MIL-STD-167, Type 1 for vibration. The static flip-flop contains 2 independent circuits plus comprehensive diode gating.

Circle No. 241 on Subscriber Service Card.

## Cable Insulation Tester

Sturrup, Inc. has introduced an economical cable and system tester.

The equipment will test 101 circuits at the rate of 30 conductors per second. Each wire of the input circuit is individually checked to ground and to every wire of the output circuit. This allows the testing of branched cables or system units where one wire may lead to several different places.

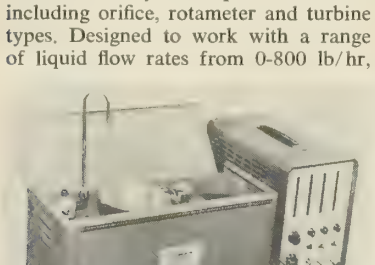


Circle No. 242 on Subscriber Service Card.

## Sheet Surfacer

Sheet surfacing operations ranging from cleaning and preparing metals for drawing to graining and polishing practically any sheet material can be done fast and efficiently on the TRI-MATIC Oscillating Sheet Surfacer available from Sales Service Mfg. Co.

The machine employs abrasive impregnated nylon mounted on an oscillating arbor which is adjustable to oscillate from 0 to 400 times per minute. The workhead drive can be equipped for single or variable speed and the feed rolls are equipped with variable speed drive. The work pressure is positively controlled and electrically metered to make it easy to maintain a constant pressure as the workhead wears and to repeat set-ups accurately.



Circle No. 243 on Subscriber Service Card.

## Thermocouple Calibration

B. & F. Instruments, Inc. is marketing a calibrator to aid in accurately recording dynamic temperature variations. For optimum accuracy while using multi-channel recording oscillographs for dynamic temperatures, it is necessary to calibrate out errors due to the loss in the input cabling. The temperature calibrator, with its own power supply does this by offering automatic 4-step calibration simultaneous or sequential; calibration sets scale for direct reading of temperature into low impedance balvanometer regardless of input lead length or resistance and it accommodates all thermocouples with their reference junctions.

Circle No. 244 on Subscriber Service Card.

## Video Logarithmic Amplifier

A fully transistorized logarithmic video amplifier LVT-2 is available from the W. L. Maxson Corp. When used in conjunction with a crystal detector mount, results in a crystal video receiver with a logarithmic input-output relationship. A 60 db dynamic range is achieved, with a bandwidth of 4 mc. Individual stage feedback permits shaping of transfer characteristic. Amplifier pairs matched to within $\pm$1.5 db can be supplied as a special item.

Circle No. 245 on Subscriber Service Card.

## Repetitive Curve Follower

It is only necessary to plot a repetitive function variation once with the Data-Trak curve follower available from Research, Inc. Continuous rotation of the data drums in the new models produces cyclical output signal variations from a pencil drawn "pattern".

Model FGE 5048 Data-Trak interprets function curves drawn as a double line with ordinary pencil on common graph paper. No special paper, pencils, or conductive inks are required.

Circle No. 246 on Subscriber Service Card.

## Pressure Intensifier

A pressure intensifier with a 15,000 psi rating and an output-input pressure ratio of 9 has been developed by Ruska Instrument Corp.

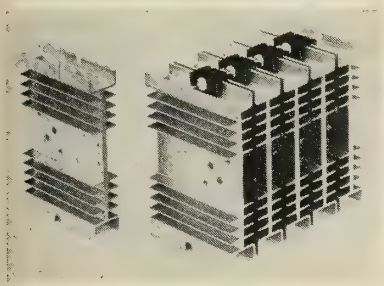
The unit is machined from stainless steel for maximum resistance to corrosion and wear. Its single-barrel construction insures precise positioning of

low-pressure and high-pressure chambers, thus minimizing war and coupling problems. Each cylinder is precision bored and honed along the barrel center line to reduce wear on compression rings by making the piston areas highly concentric. Multiple Teflon packings provide friction-free operation and long life in applications that prohibit lubrication.

Circle No. 247 on Subscriber Service Card.

## Transistor Heat Sinks

Heat Sinks for power transistors and diodes, are available from Invar Electronics Corp. Offering 25 sq. in. of surface area for each inch of length,



these heat sinks provide a large heat dissipating surface while maintaining a minimum overall size. The units were specifically designed to be used singly or in multiple heat sink arrays and are furnished with holes for mounting the power transistor, for mounting or "stacking" the heat sinks in a compact array, and for attaching a terminal or resistor board to the heat sink..

Circle No. 248 on Subscriber Service Card.

## Solid State Ring Counter

A miniature size, fast counting solid state ring counter is available from Tempo Instrument Inc. Capable of a counting rate up to 150,000 cps, (or up to 1,000,000 cps on special-order types) the unit is extremely reliable . . . guaranteed not to miss a count regardless of frequency, forward, backward, or intermittent switching. The circuit design employs dc logic for coupling the trigger signals to the counting circuits.

Circle No. 249 on Subscriber Service Card.

## Microwave Amplifiers

Microwave Electronics Corp. has in production a Ku-band solenoid-focused traveling-wave amplifier. The power output rating is 1 watt minimum, but the tubes have shown test capabilities up to 6 watts output in the center of the frequency band. The standard frequency range is 12 to 18 kmc with a minimum small signal gain of 30 db. The small signal gain variation over the band is less than 8 db.

Circle No. 250 on Subscriber Service Card.

# new literature

POWER CONVERSION — Hamilton Standard's Electronics Dept. has published a 16-page static power conversion guide which explains this field of controlled electrical power. The booklet outlines the advantages of static power equipment and provides useful comparisons between static and rotating electrical devices.

Circle No. 200 on Subscriber Service Card.

OIL FEED CONTROL—Complete details on three types of a "Circulube" automatic lubricating system which provides positive control of oil feed and circulation rates are described in a bulletin available from the Bijur Lubricating Corp. Designated "CL," this bulletin includes both photographs and engineering drawings to illustrate product data and specifications.

Circle No. 201 on Subscriber Service Card.

QUENCH OIL INDICATOR—Bulletin WS-60 available from Ipsen Industries, Inc. describes the installation and operation of the Ipsen Water Sentinel, a safety device that detects water in enclosed type oil quench tanks. Information includes several illustrations that show the components of the water sentinel as well as the installation of the unit. A graph shows response time for different water contamination levels of quenching oil.

Circle No. 202 on Subscriber Service Card.

CONTROL SYSTEM—A 12-page brochure which describes the FultroMatic control system is available from Robertshaw-Fulton Controls Co. The sales folder, numbered SF-755-A, contains a description of the basic control instrument, as well as the various means of measurement which can be employed with it. Information is also provided on FultroMatic with reset.

Circle No. 203 on Subscriber Service Card.

SERVO AMPLIFIERS—Magnetic Amplifiers Division of The Siegler Corp. has made available a 16 page color illustrated catalog (S-1169) comprising the major products of its servo amplifier line for both military and industrial applications. The catalog is comprehensive and includes specifications and application data for push-pull saturable transformers, all magnetic and transistor magnetic amplifiers, miniaturized amplifiers plus its line of transistor servo amplifiers.

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CHROMATOGRAPHY—The 5th Edition of the Shandon Chromatography Catalogue describes unique equipment not available in the U.S. before. Among these are a 20 inch two-dimensional chromatography tank; a multi-sheet chromatography tank which enables up to 50 one-way or 5 two-way chromatograms to be run simultaneously; and numerous related equipment.

Circle No. 205 on Subscriber Service Card.

ZENER PROTECTION CIRCUITS—A 4-page application note on Zener Protection Circuits for aircraft voltage surges is available from Motorola Semiconductor Products Div. The note includes circuit schematics, performance curves, and a nomograph showing quantity of zeners needed. A total of 8 illustrations supplement the text.

Circle No. 206 on Subscriber Service Card.

ORDNANCE DEVICES — Explosive-actuated devices are described in a catalog by Lockheed Electronics Co. Included in the folder are specification sheets describing a cartridge type pin-puller; an explosive rotary disconnect for remote separation of pygmy connectors; a helium dump valve; a safe and arm initiator for high-explosive systems; and a cartridge-actuated disconnect adapter for remote operations.

Circle No. 207 on Subscriber Service Card.

TRANSFORMER CATALOG—A catalog, listing latest miniature transformer information, diagrams and detailed specifications is available from Microtran Company, Inc. Typical special transformers, designed and manufactured to exacting customer specifications, are listed. Also Microtan Miniature Transformers for Electronics, Electrical, Aircraft and Missile applications—designed to meet MIL-T-27A and other military specifications.

Circle No. 208 on Subscriber Service Card.

CHRONOGRAPHS—Gaertner Scientific Corp. has published a bulletin containing complete descriptive and technical data on its line of tape chronographs, drum chronographs and precision regulator clocks. The 8-page brochure shows photographs of the equipment, provides technical information on its operation, and lists catalog numbers for all standard models, accessories, and supplies.

Circle No. 209 on Subscriber Service Card.

DYNAMIC FOCUS COIL—A bulletin which gives dimensional drawing, electrical data tables and complete description of Type F40 dynamic focus coil which provides exceptionally sharp overall focusing for 1½ in. neck diameter flat faced large angle cathode ray tubes used in high resolution applications is available from Syntronic Instruments.

Circle No. 210 on Subscriber Service Card.

## F.A.I.'s Impartiality

*To the Editor:*

I am in receipt of a copy of a letter sent to MISSILES AND ROCKETS by Mr. H. R. Gillman, Director General of the Fédération Aéronautique Internationale (M/R, Dec. 12, p. 6). The letter expressed considerable concern over the story that appeared in M/R Nov. 21 entitled "F.A.I. Rules Put Russians on Spot."

We have read the story carefully and are in complete agreement with Mr. Gillman.

As you know, NAA is the United States representative of F.A.I. and has been the sole U.S. representative since 1922. NAA has actively participated in the discussion and approval of many F.A.I. rules and regulations that apply to World and World-Class Record attempts. Since assuming the position of Executive Director of NAA on Nov. 1, 1960, I have spent considerable time reviewing the policies, procedures and work of the F.A.I. I have been completely amazed to learn that F.A.I. provides probably the only international conference table that is actually working at the present time. By this I mean that it is the only medium that I know of where representatives of both free and Iron Curtain countries sit down at a conference table and discuss and approve or disapprove rules and regulations governing all types of World and World-Class Records, and then all of the nations involved live by these rules and regulations to the letter.

All F.A.I. rules and regulations apply to all F.A.I. member nations. No rule or regulation favors one country over another, nor gives one country an advantage over the other.

For your information, all World and World-Class Records are on file at F.A.I. Headquarters in Paris, and these records are open for inspection by all member nations of F.A.I. This means that the USA can inspect USSR record claims and the USSR can inspect USA record claims.

In order to establish official World and World-Class Records in any nation, that nation must abide by the rules, whether it be the USA or USSR. No intention of breaking "secrecy barriers" is implied or practiced.

We would like to clarify one important point. Before a record is attempted, the National Aero Club of the country in which the record is to be attempted sanctions the attempt. However, this advance sanctioning merely puts the attempt on record and blocks a period of time during which no one else in that country may attempt this record. F.A.I. is not involved in sanctioning at all. F.A.I. comes into the picture only after a record has been attempted and a dossier is sent to F.A.I. Headquarters in support of a claim of a new World or World-Class Record. Therefore, there is no way that there could be a breach of security before a record attempt is made.

At the F.A.I. General Conference in Barcelona in October, a recommendation was made that a nation should file the details on its record attempt *prior* to the attempt. However, this was voted down by the delegates, and the policy remains that the details are not filed until *after* the attempt has been made and the claim to a new record is forwarded.

In order to certify a record, no country is able to "balk before complying" to F.A.I. rules. Since these rules are developed in Committee, there is no need for a nation to "capitulate," nor are "unofficial records" considered to be "cheating or exaggerating." All record claims that are certified and registered by F.A.I. are based on accuracy, proved beyond a shadow of a doubt through instrumentation, certified observers and certified statements. All of which are, as I mentioned above, open for inspection by all member nations. F.A.I. gives no thought as to whether a nation is "neutral and non-committed."

It gives us considerable concern in NAA when inaccurate statements or innuendoes are made regarding the work of the F.A.I. I believe that you will find that the F.A.I. records are of the same high quality and accuracy since its formation in 1905 and are beyond dispute. We hope that your publication will be guided by this record in its future coverage of F.A.I.

Ralph V. Whitener
Executive Director
National Aeronautic Association
Washington, D.C.

## ARS Reporting

*To the Editor:*

May I thank you for your splendid report on the recent national ARS meeting in M/R Dec. 12, and especially for your writeup "All-Solid Craft Urged for Moon Trip" on page 35, describing my proposed all-solid space launcher.

You did an outstanding job of technical reporting, and all of us here appreciate your general coverage.

H. L. Thackwell, Jr.
Senior Vice President
Grand Central Rocket Co.
Redlands, Calif.

## Mercury Viewports

*To the Editor:*

May I expand on your report in M/R, Jan. 2, about the viewports on the *Mercury* spacecraft that was flown Dec. 19? The report mentioned damage and said that the windows consisted of three or four layers of glass.

Each viewport on this capsule consisted of five panels. They are not laminated. The outer three panels, made of 96% silica glass (Vycor), served as heat shields. The inner two panels, made of strengthened aluminosilicate glass, were designed to meet a double fail-safe requirement to protect the integrity of the enclosure. Since the outer panels were designed to survive launch forces and reentry temperatures only, we were not concerned that one, two or all three of these outer panels might break from the impact of landing. In fact, the frame was designed for this possibility. Since only the outermost panel on one viewport broke on Dec. 19, we are satisfied that the viewports functioned exactly as designed.

I might mention that a later viewport design, trapezoidal in shape rather than circular, consists of four panels—two heat-shielding Vycor panels and two strengthened aluminosilicate panels. The purpose of this design is to provide more viewing area. Some *Mercury* spacecraft already are equipped with the new viewports.

A. F. Shoemaker
Product Development Coordinator
Aircraft & Missiles Group
New Product Division
Corning Glass Works
Corning, N. Y.

## Interest in Energy Chart

In the Oct. 3 M/R was a chart entitled "The Energy Level of Things."

Next week our course in physics will cover this subject and such a chart would be extremely beneficial. If possible, please send to me 12 copies.

James B. Campbell
Lt. Colonel, Arty.
Associate Prof. of Physics
United States Military Academy
West Point, N. Y.

Please send me one copy of "The Energy Level of Things."

M. Speweck, Section Mgr.
Materials Laboratories
Westinghouse Electric Corp.
East Pittsburgh, Pa.

Please send me two reprints of "The Energy Level of Things."

Ralph H. McAllister, Eng.
Designer
ANP Dept., General Electric Co.
Cincinnati

I have read with great interest the chart entitled "The Energy Level of Things" by J. R. Williams. If reprints are available, I would appreciate your sending one to me.

Samuel Bousky, Chief Scientist
Chicago Aerial Industries
Barrington, Ill.

*The chart was authored by Jean R. Williams, of the Air Force Special Weapons Center (ARDC), Kirtland AFB, N.M., and made available to M/R by the Air Force Office of Scientific Research. Reprints may be obtained free of charge by writing to this magazine.—Ed.*

# when and where

## JANUARY

**American Astronautical Society, Annual Meeting,** Sheraton-Dallas Hotel, Dallas, Texas, Jan. 16-18.

**Lectures in Aerospace Medicine, School of Aviation Medicine,** Brooks AFB, Texas, Jan. 16-20.

**Winter Instrument-Automation Conference & Exhibit,** Instrument Society of America, Jefferson Hotel and Kiel Auditorium, St. Louis, Mo., Jan. 17-19.

**Institute of the Aeronautical Sciences 29th Annual Meeting,** Hotel Astor, New York, **(Honors Night Dinner** Jan. 24) Jan. 23-25.

**1961 Plant Maintenance & Engineering Conference, International Amphitheatre,** Chicago, Jan. 23-26.

**American Mathematical Society, National Meeting,** Willard Hotel, Washington, D.C., Jan. 24-27.

**Society of Plastics Engineers, Annual Technical Meeting,** Shoreham and Sheraton-Park Hotels, Washington, D.C., Jan. 24-27.

**American Institute of Electrical Engineers, Winter General Meeting,** New York, N.Y., Jan. 29-Feb. 3.

**American Society for Testing Materials, Committee Week,** Netherland Hilton Hotel, Cincinnati, Ohio, Jan. 30-Feb. 2.

**American Physical Society,** New Yorker Hotel, N.Y.C., Jan. 31-Feb. 4.

## FEBRUARY

**Institute of Radio Engineer, PGMIL,** Los Angeles, Calif., Feb. 1-3.

**American Rocket Society, Solid Propellant Rocket Conference,** The Hotel Utah, Salt Lake City, Feb. 1-3.

**Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (unclassified),** South Texas Section of SNT and Southwest Research Institute, Gunter Hotel, San Antonio, Feb. 14-16.

**Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting,** Sheraton Hotel, and University of Pennsylvania, Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, La., Feb. 26-Mar. 1.

**Association of Iron and Steel Engineers,** Los Angeles, Calif., Feb. 28-Mar. 2.

**Western Joint Computer Conference,** Los Angeles, Feb. 28-Mar. 1.

## MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.


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**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

# reviews

PERCHLORATES, ACS Monograph No. 146, edited by J. C. Schumacher, Reinhold Publishing Corp., N.Y., 257 pp., $8.75.

The author developed the material from the point of view of the manufacturer interested primarily in finding and developing novel, economical and safe methods of manufacture, handling and use of the perchlorates and perchloric acid.

An entire chapter is devoted to the growing use of perchlorates in the explosives and propellants areas. Safety considerations are extensively treated.

TOXICITY AND PERSONAL DECONTAMINATION OF BORON HYDRIDE PROPELLANT FUELS, S. Rothberg and others. Order PB 161772 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 16 pp., $.50.

A mild ammonia solution proved effective as a flushing agent in removing toxic boron hydride fuels from the skin of test animals. The experiment was conducted as part of an Army study of the toxic effects of boron hydride propellant fuels and the value of various decontamination measures.

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American Steel Foundries, Hammond Div. ..... 33
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Bell Aerosystems Co., a Div. of Bell Aerospace Corp. .. 52
Agency—The Rumrill Co., Inc.

Bristol Siddeley Engines, Ltd. 18
Agency—Young & Rubicam, Ltd.

Dilectrix Corp. ..... 6
Agency—Arthur H. Haut Assoc.

W. C. Dillon & Co. ..... 43
Agency—Gordon L. Van Der Boom, Adv. Agency

Elgeet Optical Co., Inc. ... 10
Agency—The Wexton Co., Inc.

Hallicrafters Co., The ..... 3
Agency—Henry B. Kreer & Co., Inc.

Hughes Aircraft Co. ..... 51
Agency—Foote, Cone & Belding

Leach Corp. ..... 2
Agency—Hixson & Jorgensen, Inc.

Lincoln Laboratory—Massachusetts Institute of Technology ..... 7
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Agency—J. M. Mathes, Inc.

Lockheed Aircraft Corp., Missiles & Space Div. ..... 8
Agency—Hal Stebbins, Inc.

Northrop Corp. .....26, 27
Agency—Doyle, Dane, Bernbach, Inc.

Spincraft, Inc. ..... 38
Agency—The Mautner Agency


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Amcel Propulsion Inc., a Sub. of Celanese Corp. of America ..... 49



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# On Nuclear Power and Safety

IF THE UNITED STATES is to compete successfully in space exploration, with its power-hungry technical requirements, the development of nuclear energy into rocket propulsion is completely and inevitably necessary.

There is evidence, however, that the fears of radioactive contamination reflected in world opinion are holding back an active development and testing program without real cause.

There is a danger of contamination, of course. There probably always will be, where nuclear power is used. But the fears—and they do create a political force—are frequently vague surmises formed with little real basis in fact.

Lt. Col. Joseph A. Connor, Jr., a USAF medical officer and chairman of the Aerospace Nuclear Safety Board of the AEC, attacks some of these current fears or misapprehensions in a paper delivered recently in San Francisco.

Examining the U.S. nuclear propulsion projects, SNAP and ROVER, Col. Connor has considered their safety factors in considerable detail. This includes protection of crews and of the public; selection of ranges and re-entry burnout, launch pad failures and contamination of the upper atmosphere.

He points out that the AEC's Aircraft Nuclear Propulsion Office has spent $4 million in intensive and long-term studies of the patterns and possibilities of radiation resulting from nuclear accidents. A comparable amount has been spent on studies of shielding.

In making these studies and tests, the worst theoretical accidents have been studied.

Appraisal of the radiation risks, says Col. Connor, "reveals them to be no more than those risks encountered in the progressive development of steam and electric power, the airplane, the automobile or the rocket.

"Just as the uses of the older forms of energy have been governed by considerations of safety, so will the ultimate role of nuclear energy in space be largely determined by its safety.

"The conclusion reached is that the use of nuclear-powered devices sufficient to meet all space requirements expected to be developed by 1980 would release but a small fraction of the radioactivity considered by the Federal Radiation Council Guides to be tolerable for the general population."

(Just for effect—compare a possible mishap with a SNAP 8 generating 30 electrical kilowatts with the explosion of a multiple megaton atomic bomb on the Nevada or Sahara deserts).

THE FACT IS—again—that nuclear energy is an inevitable part of space exploration technology.

The advantages of nuclear power bring with them a price that man must pay. He either pays it by absorbing unacceptable amounts of ionizing radiation or he provides for safety, accepting what handicaps this may bring.

The AEC Nuclear Safety Board obviously believes the safety requirements can be met, both for the crews who operate the devices and for the public at large.

It will take more than one report to convince the world. If we wait until the world is convinced we are very apt to be far behind other nations who may not be so considerate. We should get on with the program. In the final analysis the real proof will come only with the doing.

**Clarke Newlon**

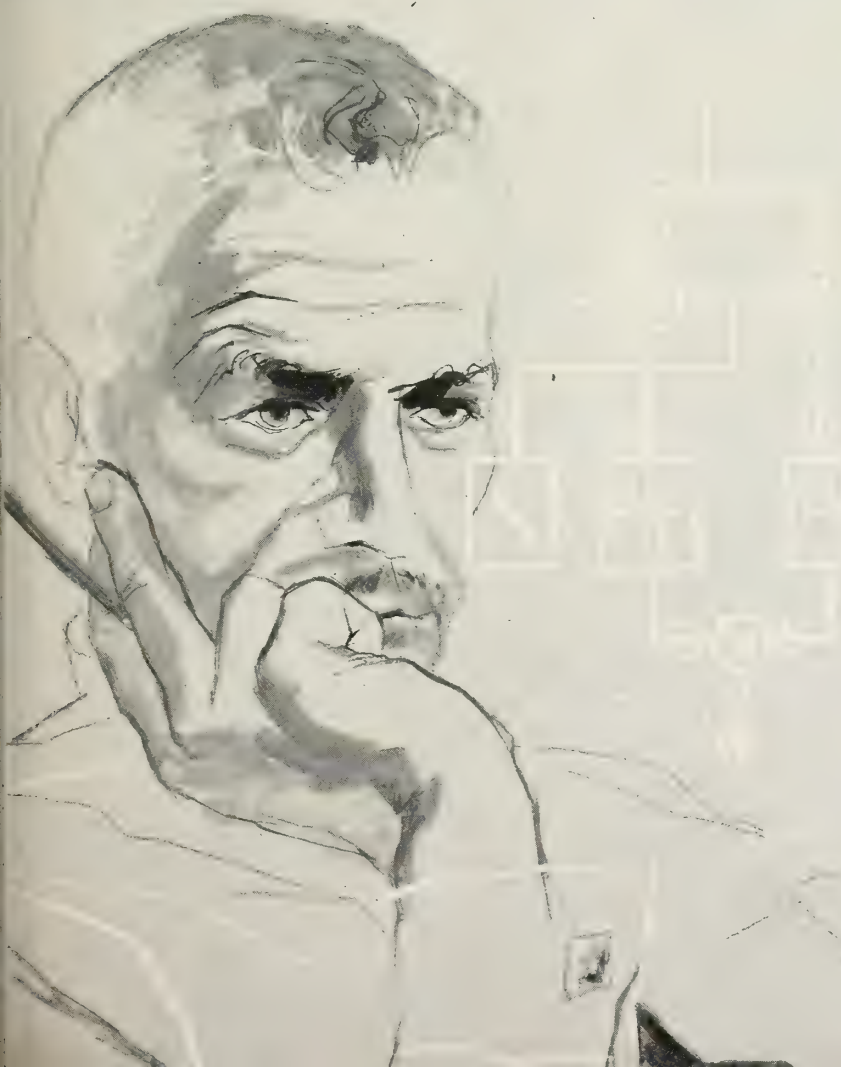
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detection, space propulsion systems or related areas. Several of the positions require the ability to present contract proposals to both technical and non-technical officials. Other positions require the ability to do preliminary systems design. There are twenty-three openings in the above areas at the present time.

All of the positions involve close associations with senior engineers. All of the salaries reflect the unusual backgrounds required.

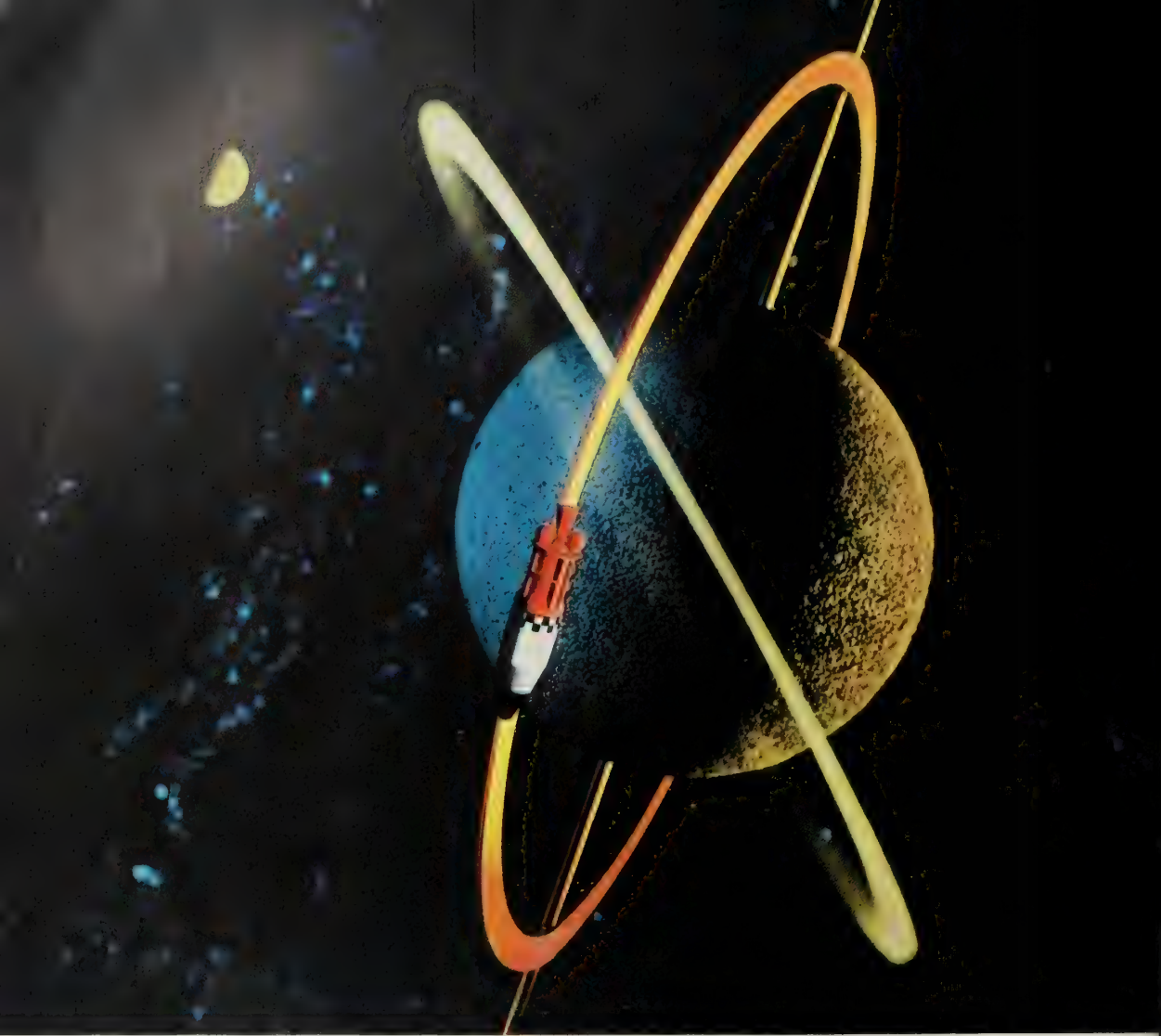
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The Agena engine, designed with space in mind long before space became a household word, has fulfilled its every mission and has placed more tons of useful payload into orbit than any other power plant. Its operational reliability is backed by six years of development and 5,000 test firings.

This Bell engine now has re-start capability — the first in the nation. This means that its satellite can change orbit **in space** without the penalty of extra engines. Presently in production, this engine also is adaptable to new fuels and new assignments and, consequently, is programmed for important military and peaceful space ventures of the future.

Agena's engine is typical of the exciting projects in Bell's rocket propulsion center. It is part of the dynamic new approach of a company that's forging ahead in rocketry, avionics and space techniques. These skills serve all government agencies. Engineers and scientists anxious for a new kind of personal challenge can find it at Bell.

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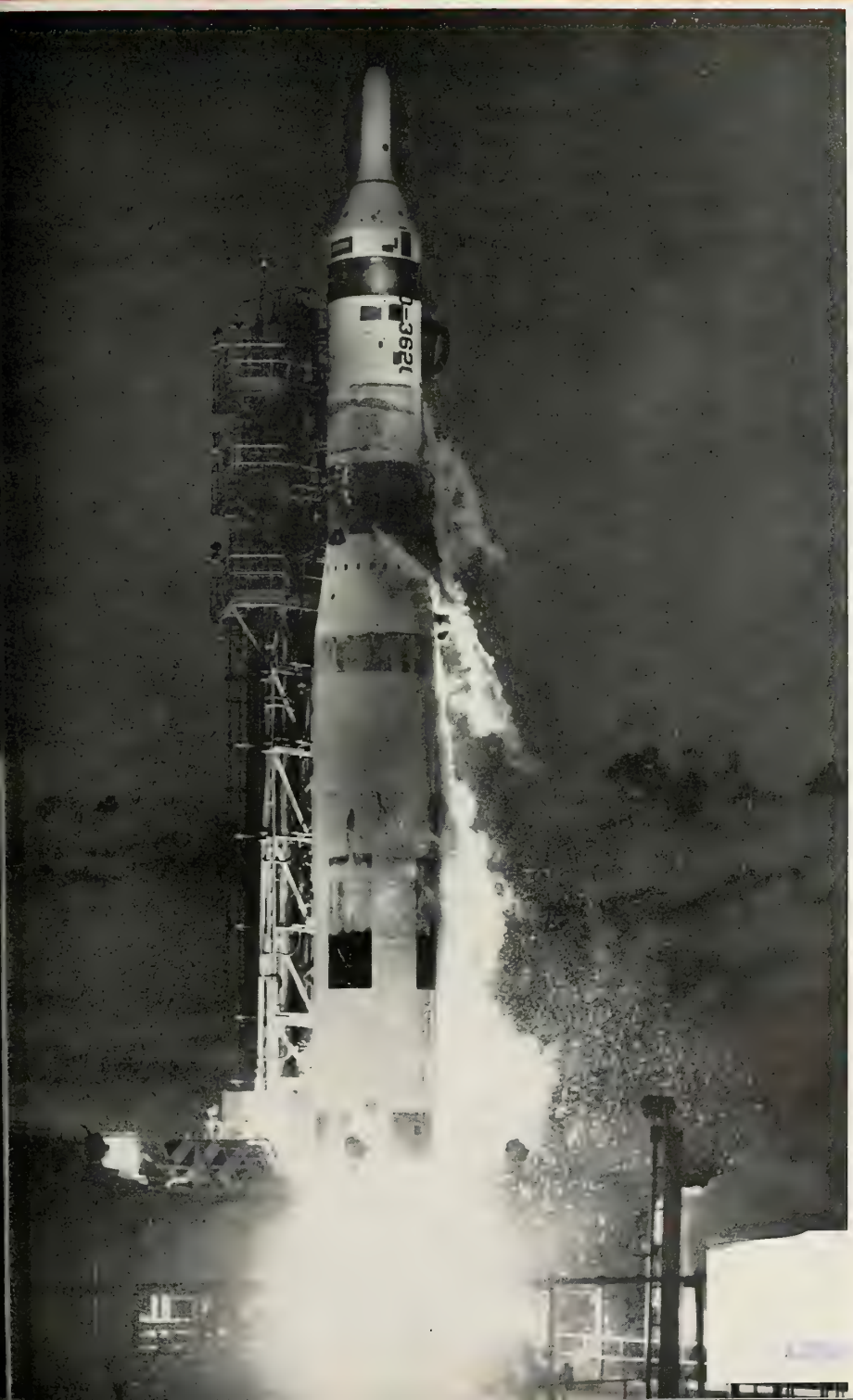
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# missiles and rockets

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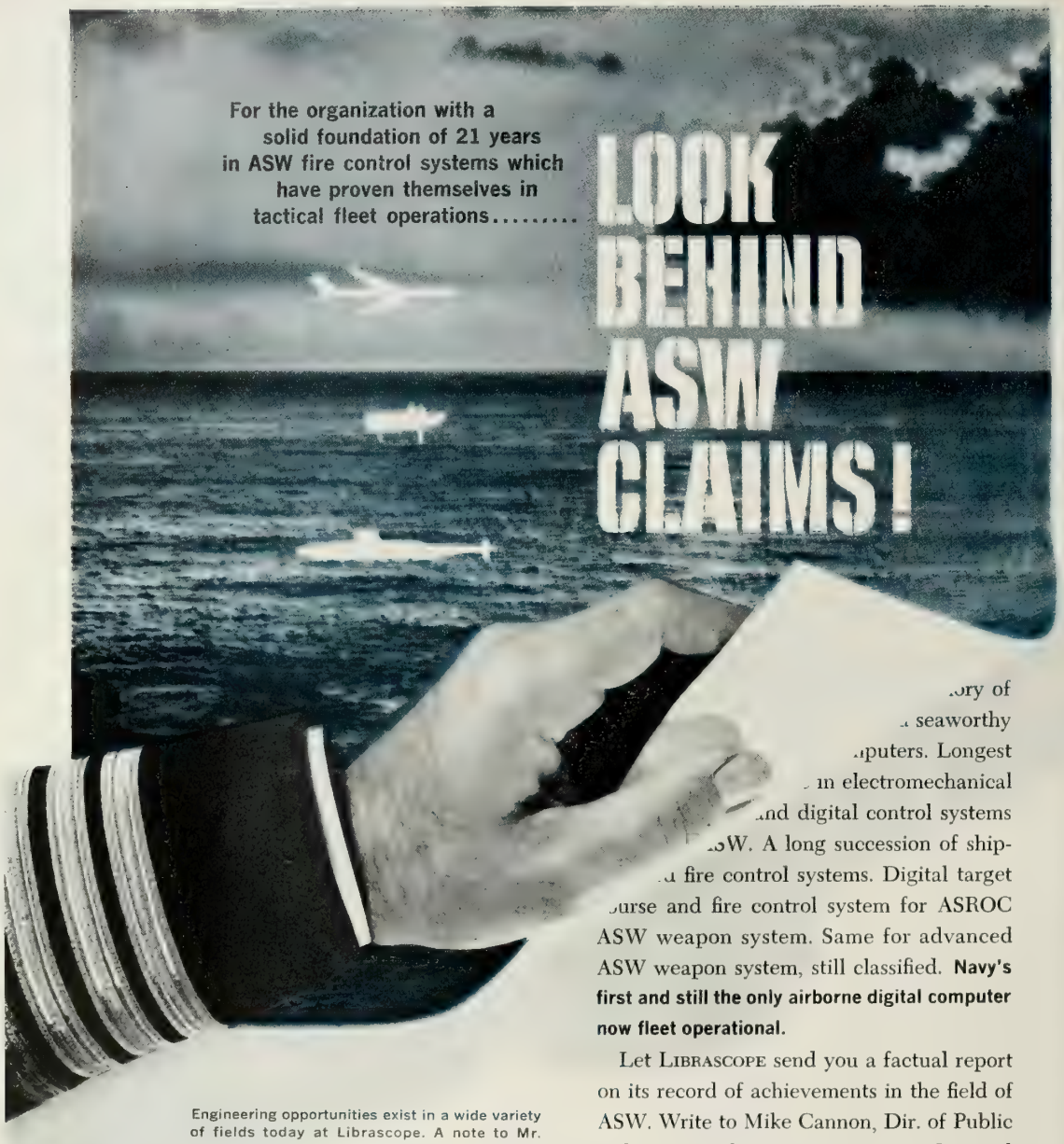


## Proposals Could Add $4 Billion To Budget

- USSR Boosts Rocketry R&D
- Better Space 'Image' Sought
- Challenge of Glass Viewport

*Titan Test—Big Birds Get Push in '62 Budget*

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# He put a new twist in an old trick

His problem was to take a 3"x6"x 3-foot piece of wave guide tubing made of .08-inch thick aluminum and to twist one end 90° to the other *without buckling or stretching any part of it...so that a cross section taken anywhere along its length remained a perfect rectangle.*

The standard solution for a problem like this: Support the tube internally with a solder-like substance that's melted in, cooled, melted out after twisting. It won't work here because the mass of the substance is too great.

Here's how this AMF production engineer found the answer. First, he visualized the concept that, in any symmetrical twist, *the center axis never moves.* Then he applied this concept by stringing a metal rod through the center of 288 rectangular shims, inserted them in the tube, cushioned them with the same solder-like substance. Jaws clamp on either end. One of them rotates *slowly* (twisting time: over 2 minutes) giving the metal time to flow. The result: Perfect twists, every time.

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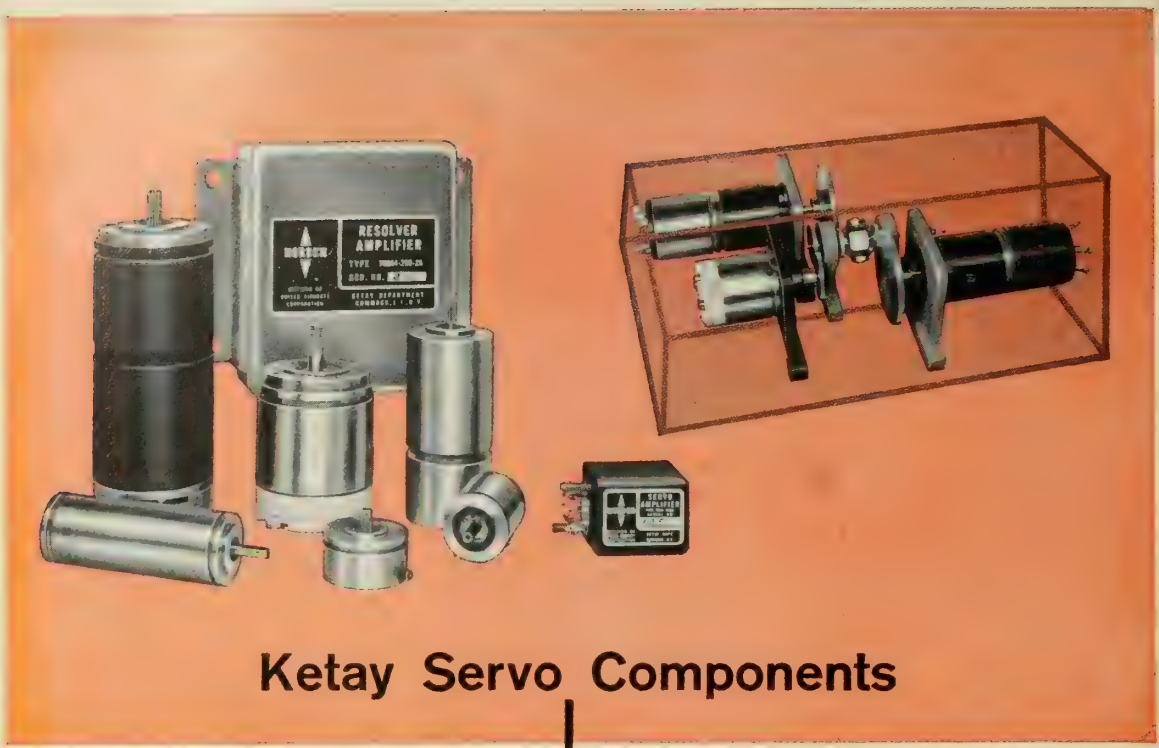
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• • •

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 4 January 23, 1961

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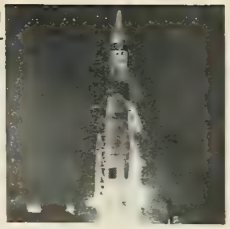
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## THE COVER

*Titan lifts from Cape Canaveral in latest test of Air Force ICBM. Along with others in "Big Four" ICBM group, it will get a big hunk of Fiscal Year '62 budget. See p. 11.*

## JANUARY 23 HEADLINES

FY '62 Defense Budget Could Climb $2-4 Billion .... 11
Soviet Budget Weighted with Military Spending ..... 14
Administration to Seek Better U.S. Space 'Image' .... 16
Schriever Tells of Forthcoming Space Blueprint ..... 18
Four Firms Form Joint Source for Contracting ..... 36
First Centaur Flights to Precede Tracking Net ..... 37

## SPACE MEDICINE

Reports on Sputnik V Show Life Science Know-How .. 22

## ELECTRONICS

Servonics TWS Is Highly Versatile System ..... 29

## ADVANCED MATERIALS †

MTC Solves Silicone Rubber Tubing Problem ..... 32
Liquidometer Measures Weightless Liquids ..... 32
Superior Tubing Takes Wind Tunnel Pressures ..... 35
Tiros II Radiometer to Improve Weathercasting ..... 35

## ASW ENGINEERING †

Sonobuoys Pose Detection Threat to Subs ..... 38

## ENGINEERING

Space Viewports Challenge Glassmaking Industry ... 40

## DEPARTMENTS

The Countdown ..... 7
The Missile/Space Week † ..... 8
Technical Countdown . 21
Industry ..... 43
Books ..... 44
Contracts ..... 45
Names in the News .. 46
Products and Processes 47
When and Where .... 49
Editorial ..... 50

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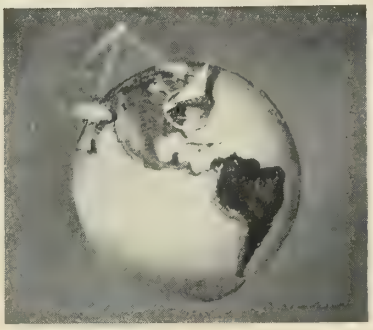
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# Where was the Bell Telephone System

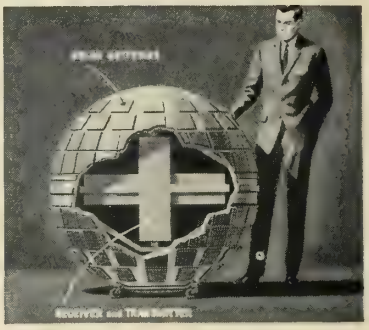
## ON FRIDAY, AUGUST 12, 1960?



It was handling some 210,000,000 local and long distance conversations, plus about 5000 overseas calls.



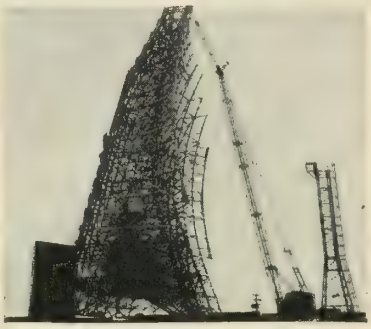
It was guiding Echo I into near-perfect orbit so Bell System scientists could make the world's first telephone call via satellite.



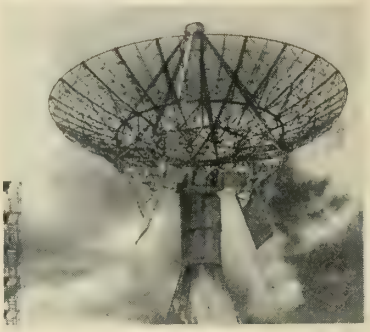
It was developing a world-wide communications system using satellites powered by the Solar Battery, a Bell System invention.



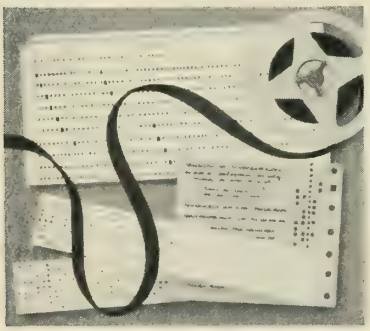
It was offering Bellboy personal signaling to more and more people. Device uses tiny Transistors, another Bell System invention.



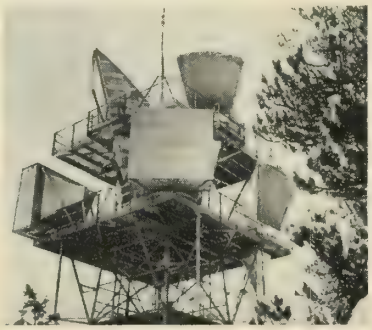
It was building fast, reliable communications for BMEWS—the nation's Ballistic Missile Early Warning System.



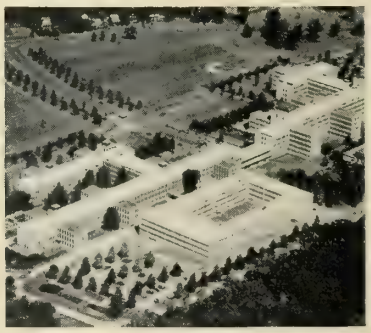
It was constructing a 'round-the-world communications system for America's first man (or woman) into orbit.



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# The Countdown

## WASHINGTON

### A $2 Billion Supplemental Budget?

The military services are pressing for a supplemental defense bill for FY '61 that would give the nation's strategic power a powerful boost. Among the top items: A big push for *Minuteman,* three more *Polaris* submarines, some speed up money for *Atlas* and *Titan,* and *Nike-Zeus* production. Cost (including some other additions): $1.5 to $2 billion.

### The Bomber and the Missile

The earlier-than-planned end of bomber production (See budget p. 11) by budgetary fiat immediately raised the question of whether the big missiles are being deployed fast enough to take the bomber's place. A number of planners are saying the missiles weren't being deployed fast enough with continued bomber production let alone without it.

### Dr. Wiesner: Man of Many Roles

The influence of MIT's Jerome Wiesner, President Kennedy's chief science adviser, is already showing itself to be widespread. Before taking on his new job, Dr. Wiesner headed Kennedy's secret Ad Hoc committee that reported on lags in U.S. space programs. Dr. Wiesner also has been working since October on an Air Force Space Study Committee named by Lt. Gen. Schriever, ARDC commander. The committee will report next month on "potential Air Force space developments."

### NASA: Almost a Shot a Week

Launching plans at NASA calls for a series of at least five space launchings in the first six or seven weeks of the Kennedy Administration. They include: The slipping *Mercury Redstone* shot with a chimpanzee in a matter of days; a beacon *S-45* satellite the week of Feb. 6; a repeat launch of a "baby *Echo*" *Scout* satellite and *Mercury Little Joe 6* during the week of Feb. 13; a P-14 magnetometer probe during the first week in March.

### Shipboard Polaris—$55 Million

There's little doubt the Navy will go ahead as quickly as possible with long-tabled plans to outfit the nuclear cruiser Long Beach with eight *Polaris* missiles, now that it has authority to do it. Cost: about $55 million, which will have to come out of the Navy's hide. This will bring the total cost of the Long Beach up to $375 million. Best guess is that the Long Beach, which has slipped more than a year because of strikes, will go to sea in the fall without the missiles. It probably will be returned to the Bethlehem Steel Co. yard at Quincy, Mass., for retro fitting early next year.

### Historical Note

The Navy was ready in 1959 to put *Polaris* aboard the Long Beach to operate in the Indian Ocean—making the cruiser a "one ship Navy." (It is also armed with *Terrier, Talos* and *Asroc.*) But former Defense Secretary McElroy ordered work held up until the idea could be reviewed by the Joint Chiefs of Staff. Just as he was ready to leave office last week, Defense Secretary Gates finally gave a go ahead. But just for the Long Beach. Plans to "plug in" *Polaris* units on other surface ships are staying on the shelf.

## INDUSTRY

### Paper and Talk Circuit

Expect more companies in the missile/space industry to start turning a cold shoulder on the growing number of meetings, conferences, conventions and symposiums set up by various organizations. Reason: too expensive, too time-consuming, and the lack of quality of papers. The military services feel the same way.

### Titan III—200 ft. High

COUNTDOWN is told that some planning already has gone into the launch and transport facilities for *Titan III* —a monster booster. Vehicle would resemble configuration of present *Titan,* but would be 200 ft. high. It would be used for launching an advanced *Dyna-Soar* (or possibly other space vehicles) unless *Dyna-Soar* is shelved in favor of *Aerospace Plane.*

### Front Office Talk

Signal Corps funding for the AN/USD-5 surveillance drone being built by Fairchild at Hagerstown, Md., is now hitting $50 million annually, is not expected to decrease soon. . . . There will be an AF-Martin development engineering inspection of *Titan II* in Denver at the end of this month. . . . Six companies—RCA, GE, TEMCO, Grumman, Bendix and Republic Aviation—are in the hot competition to prime NASA's *Nimbus* weather satellite. . . . RCA's Defense Electronics Products Division will establish a long range planning office in Washington shortly. The director already has been picked.

### Automated Tooling

Look for a step-up in missile/space industry efforts to refine and expand the use of APT (automatic program tooling system). Initial tests show dramatic 80% reduction in manhour requirements for certain items. Aim is to cut years off of development time for special tools.

### Space Pound Drop

Latest estimate of vehicle cost for putting a pound of payload into orbit using *Saturn* is $600—against a $15,000 figure reported for present operational U.S. space boosters.

## INTERNATIONAL

### Australian Missile Subs

Unable to afford atomic-powered submarines, the Australian government has decided to equip three conventional submarines with missiles. Type of missile is unspecified. Five more submarines may be added within three years. Meantime, the Navy is asking for guided missile cruiser. Australia's first air defense missile base, incidentally, has just gone operational. It is at Newcastle, New South Wales.

### Overseas Pipeline

Britain's attempt to start up an international space research program will reach the "moment of truth" Jan. 30 at a 12-nation Meeting in Strasbourg, France. Question of whether the booster will be *Blue Streak* may decide whether the venture goes through. . . . Russia is believed about to come to terms on setting up a UN Conference on Peaceful Uses of Outer Space, a project it has stalled for more than a year.

### Bimbo Test Nears

The Air Force is getting ready to static-test a segmented solid rocket about the size of the one-piece *Minuteman* first stage, weighing 20 tons.

Aerojet-General is building the experimental rocket—unofficially named "Bimbo"—with an expected thrust of 400,000 lbs. Burning time, while not disclosed, would appear to be in the neighborhood of 25 seconds. The Air Force rocket will be almost seven times as heavy as a three-segment rocket tested in November by United Technology Corp. for the National Aeronautics and Space Administration.

Although the number of segments was not disclosed, the Air Force said motors with more segments will be fired later in the year.

### Chimp Awaits Choice

The chimpanzee for the *Mercury Redstone* flight will be chosen from a group of six now at Cape Canaveral about 24 hours before launch. The 40-lb. animal, between 1½ and 2½ years old, will be strapped into its harness at minus 5 hours, set into the capsule at minus 2 hours, and the last bolt of the capsule will be closed at minus 45 minutes.

The chimp's container will be connected with the astronaut's suit for air, but the animal will be in a separate life capsule. NASA spokesmen, obviously discouraging any wide public interest in the animal, declined to announce names and sex of the six candidates.

### New Trailblazer in Works

A new version of the *Trailblazer* re-entry test vehicle, cutting the number of stages from six to four, is being put together by Atlantic Research Corp. on a contract with Air Force's Lincoln Laboratory.

The four-stage version, *Trailblazer II*, is made up of a Thiokol *Castor* and two auxiliary *Recruits* as first stage and a Grand Central *Lance* second stage. For the downward thrust, designed to accelerate a re-entry body to more than 25,000 fps, Hercules X248 and a NASA 15-in. spherical motor will be used for the tests due to begin at Wallops Island, Va., in the spring.

### State-DOD Team Planned

Top State Department and Department of Defense personnel are being swapped in an exchange program to help meet some of the knotty problems demanding both military and foreign service know-how.

A sample of the problems the group presumably might have to attack is the recent furor over the dropping of a *Thor* booster on Cuba after an attempted U.S. satellite launching. Another critical area is the education of world opinion on testing of U.S. small nuclear power devices, such as in the SNAP program, and eventual testing of nuclear rockets.

Eleven top men will be tapped from each department during the next few weeks. DOD will exchange four from the Office of the Secretary of Defense, two each from the Departments of the Army, Navy and Air Force and one from the Joint Staff. Those chosen will be senior officers with rank of Lt. Col. or Colonel or equivalent.

The program was proposed by Secretary of State Herter before the Subcommittee on National Policy Machinery of the Senate Committee on Government Operations. Under the plan, the participants will be assigned a tour of duty lasting two years, during which they would serve as an "integral part of the host agency."

### Keeping Hill Posted

Congress will get a $135,000 fund to help keep it abreast of Soviet and U.S. space progress.

The Senate Space Committee, headed by Sen. Robert S. Kerr, approved the appropriation for the purpose of giving Congress "as close a look as we can have" at U.S. needs —including what other nations are doing.

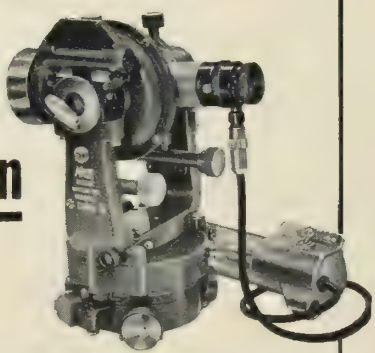
Kerr also promised that the committee would try to help clear the way so that Vice President Johnson


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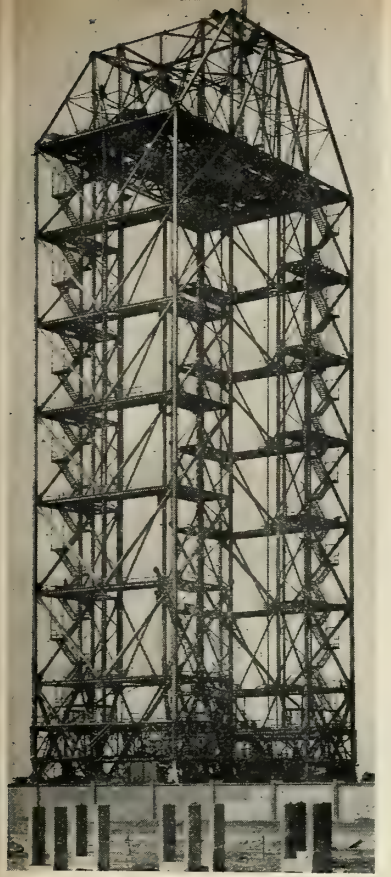
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can head the National Space Council. The National Space Act as presently written calls for the President to head the council, but President Kennedy has named Johnson to the post.

## Delayed Recognition

An unsinkable admiral with a one-track mind—for an all-nuclear Navy—received the service's distinguished service medal (DSM), highest peacetime decoration.

Ironically, the honor came to Vice Adm. Hyman Rickover, developer of the atomic submarine, nearly 10 years after a board of admirals sought his retirement by refusing to promote him to flag rank. It was also six years to the day and hour of the launching of the Nautilus, first atom-driven sub. The Admiral was decorated in conjunction with keel-laying ceremonies for the *Polaris* sub Lafayette.

## Cooperation Progresses

Japan is negotiating with the National Aeronautics and Space Administration in hopes that she may launch a satellite from a U.S. pad in 1963. The plan evolved from NASA's offer last fall to launch or provide cooperation on satellite ventures in any country.

Meanwhile, France's plans to participate in the program received impetus with the announcement that Pierre Auger, head of the French Space Committee, will visit the U.S. in the next several months to discuss a joint U.S.-French venture.

Last week, Italian scientists launched two rockets with U.S. instrumentation from the Isle of Sardinia to study density and currents of the upper atmosphere.

Other countries sharing in the program are Canada and Great Britain, whose satellites will be launched in 1962. Plans for a joint Australian-U.S. probe to be launched from Woomera are under consideration.

NASA has also said it will cooperate with the 11-nation group being formed in Europe for joint space programs. A decision is expected soon on whether the group will seek to develop the British *Blue Streak* for a space booster, or procure boosters from other sources.

## Small Business Hurting

Small business is getting the squeeze-play in the military procurement market because of Pentagon restrictions on competitive bidding, a Senate committee has found.

The Small Business Committee blasted Pentagon procedures in space parts buying. It charged that if spare parts replenishment were open to competitive bidding, it would not only save the taxpayer 30-40% of the costs, but open more opportunity to small business.

Since 1954, the committee contends, small companies' share has dwindled from 25.4% of the defense supplies and services market to 16.1% in 1960. What's more, the report adds, DOD advertised contracts for competitive bidding valued at $3.2 billion, but negotiated $18.9 billion worth of contracts. Of these 12.6% were awarded on the basis of price competition; 67.4% went to a single supplier.





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# Budget '62: More?

## $10 Billion Asked for Missile/Space

***But M/R analysis shows proposals going before Kennedy Administration may boost contracting $2-4 billion over Ike's stand-pat budget. New plans would push big missiles and astronautics to meet fresh Soviet challenges in East-West struggle***

**by James Baar**

MAJOR MISSILE/SPACE Proposals that would swell the final Eisenhower budget by $2 billion to more than $4 billion are being laid befor the Kennedy Administration.

The stand-pat Eisenhower budget for FY '62 already contains well over $10 billion in planned obligations in the missile/space field. The proposed increases would not only boost that figure greatly but also form a base for large boosts over the next several years.

So far, the members of the new Administration have only hinted at possibly large increases to support President Kennedy's campaign promises to bolster U.S. efforts in the Cold War. However, the Pentagon's new civilian bosses and other members of the Administration have been at work for several weeks reviewing what might be done.

Any increases proposed by the Kennedy Administration will come about in one or all of three ways:

–A fast supplemental money request for FY '61 sent to Congress sometime within the next few weeks. Most likely this would mainly be designed as a shot in the arm for the "Big Four" strategic missile programs.

–The use of about a half-billion dollars in military appropriations which the Eisenhower budget proposes to carry over into FY '62. This could be done by White House order without legislation.

–An amendment to the Eisenhower FY '62 budget. This probably would be sent to Congress by the White House around April.

• **Spending battlelines**—Any sizable increase in missile/space obligations and spending is expected to result in deficit financing in the early stages of the new Administration.

However, Administration planners are reported to have already resigned themselves to further increases in the nearly $285 billion national debt—at least during Kennedy's first year in office. Moreover, the Democrats have pointedly stated that the precariously-balanced final Eisenhower budget achieved its balance on the basis of non-existent tax revenues and an assumed economic upturn.

Senate Majority Leader Mike Mansfield commented drily that the Eisenhower budget's balance "disappears on close inspection." And he added: "Now we'll wait and see what the real budget looks like when it is presented by Mr. Kennedy."

Senate Minority Leader Everett Dirksen took exception to Democratic comments. He called the Eisenhower budget "honest . . . unpolitical . . . (and) not designed to put anyone in the hole."

Outgoing Budget Chief Maurice Stans sharply warned that it would be fiscally unsound to increase the final Eisenhower defense budget and added: "A few statements of confidence on the part of the next Administration would do more for the economy than a few billion dollars of defense spending."

Thus the political lines were drawn for a battle over spending. But the real battle was more likely to turn on the present state of the Cold War and the Space Race.

• **Fictitious gaps?**—Former President Eisenhower threw out a challenge to the Kennedy Administration on both counts in his final days in office.

The first challenge came in Eisenhower's last State of the Union Message when he defended his defense policies over the last eight years.

"Every dollar uselessly spent on military mechanisms decreases our total strength and, therefore, our security," he said. "We must not return to the 'crash' program psychology of the past when each new feint by the Communists was responded to in panic."

Then he said: "The 'Bomber Gap' of several years ago was always a fiction and the 'Missile Gap' shows every sign of being the same."

The charge that the Missile Gap appeared to be fiction is understood to be based on the inability of U.S. intelligence sources to locate as many missiles on launchers as Russia was expected to have by this time.

Military critics of the conclusion that the expected missiles do not exist point out that with the cessation of U-2 flights Russia could very well have successfully hidden a large number of missiles in the vast Eurasian land mass. They also point out that Russia is putting an increasing number of its missiles at sea in conventional and nuclear submarines.

• **Reversing space slow-down**—Eisenhower's challenge on increasing U.S. efforts in space came in his last budget message.

He stated bluntly: "Further testing and experimentation will be necessary to establish whether there are any valid scientific reasons for extending man-

### Missile/Space Obligations In FY '62 Budget

*(in millions)*

| | |
|---|---|
| Missile Procurement | $3,971 |
| Missile RDT&E | 1,581 |
| *Missile Construction | 250 |
| NASA R&D | 820 |
| NASA Construction | 101 |
| Military Astronautics | 584 |
| Military Sciences | 687 |
| Foreign Aid Missiles (including electronic support) | 263 |
| *Missile Maintenance | 1,500 |
| *Ships (Polaris subs and other missile seaborne GSE) | 700 |
| TOTAL | $10,457 |

*Estimates

in-space flight beyond the *Mercury* program."

The former President, never a warm advocate of military or civilian space programs, acted on his statement by cutting back both the Air Force's *Dyna-Soar* and NASA's *Apollo*—the nation's two programs aimed at development of a true manned spacecraft.

Finally, he used his farewell address to the nation to warn against such "costly action (as) a huge increase in newer elements of our defense (as) a miraculous solution to all current difficulties."

He also advised the nation to be on its guard against the present "conjunction of an immense military establishment and a large arms industry."

"We have been compelled to create a permanent armaments industry of vast proportions," he said. "Added to this, three and a half million men and women are directly engaged in the defense establishment.

"In the councils of government, we must guard against the acquisition of unwarranted influence whether sought or unsought by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist."

Even as he talked the Russians continued preparations for what many expected to be a new spectacular stride into space and Soviet Premier Khrushchev declared in a newly-published speech that Communism soon would rule the earth.

Khrushchev added amiably that war would not be necessary for Communism to achieve victory over the West—unless, of course, the capitalistic nations tried to resist.

## Budget Close-up

The most significant parts of the Eisenhower missile/space budget were the exclusions.

–No bomber procurement for the first time in a quarter century. The purchase of B-52's and B-58's was abruptly ended. All manned bomber production was scheduled to cease in calendar 1962. R&D on the Mach 3 B-70 alone would continue.

–No acceleration of the deployment of strategic missiles. This would mainly have involved *Minuteman* and *Polaris*. The Navy had sought to move quickly into building 12 *Polaris* subs a year. It got five and long-lead-time parts for five more.

–No production money for the *Nike-Zeus* anti-missile missile. The Army received R&D money: about $250 million. The budget said flatly: "Funds should not be committed to production until development tests are satisfactorily completed." That would be more than a year away.

–No big increases for military or civilian astronautics. A number of key areas were cut back instead.

In almost all areas, the Eisenhower Administration chose to stand pat or trim. However, despite this, the total defense budget still called for spending $42.9 billion.

That made it $1.5 billion higher than the current fiscal year and the second highest defense spending budget since World War II. It also claimed more than half of the total Eisenhower spending budget of $80.9 billion.

The very immensity of the defense budget plus $965 million for NASA plus several hundred million dollars more for foreign aid missile procurement and other missile/space expenditures underlined the fiscal problem confronting Kennedy.

If nothing were added to the presently-proposed defense budget, it is expected through built-in increases to rise to about $44 billion by the next fiscal year. That would push defense spending beyond the post-World War II peak year in FY 1952 when it hit $43.7 billion.

But this is far from the whole story.

When the defense budget hit $43.7 billion in FY '52 the Gross National Product was only $347 billion. The GNP in FY '62 is expected to be about $515 billion. Therefore, spending under the defense budget has declined from about 12% of the GNP to about 8%. Moreover, the value of the dollar over the last eight years has declined.

The increasing budget squeeze is the result.

Besides the continuation of tight budget ceilings on the three military services and NASA, the most prominent trend in the budget was the accelerated swing away from aircraft to missiles.

"Just a few years ago," Eisenhower said in his budget message, "the United States was programing twice as much money for manned bomber systems as for strategic missile systems."

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| | | New Obligational Authority | | Direct Obligations | | Expenditures | |
|---|---|---|---|---|---|---|---|
| | | FY '61 | FY '62 | FY '61 | FY '62 | FY '61 | FY '62 |
| ARMY | Missiles | 496 | 457 | 542 | 457 | 474 | 490 |
| | Astronautics | 42 | 57 | 40 | 57 | 5 | 47 |
| | Military Sciences | 154 | 188 | 176 | 188 | 146 | 166 |
| NAVY | Missiles | 730 | 684 | 711 | 681 | 715 | 722 |
| | Astronautics | 11 | 23 | 28 | 23 | 20 | 21 |
| | Military Sciences | 124 | 141 | 139 | 138 | 130 | 132 |
| AIR FORCE | Missiles | 165 | 181 | 585 | 443 | 446 | 430 |
| | Astronautics | 467 | 493 | 424 | 504 | 331 | 488 |
| | Military Sciences | 80 | 110 | 143 | 134 | 111 | 130 |
| ARPA | Astronautics | . . . | . . . | 19 | . . . | 71 | 13 |
| | Military Sciences | 164 | 164 | 229 | 164 | 211 | 190 |

## Military Procurement

*(in millions)*

| | | New Obligational | | Direct Obligations | | Expenditures | |
|---|---|---|---|---|---|---|---|
| | | FY '61 | FY '62 | FY '61 | FY '62 | FY '61 | FY '62 |
| ARMY | Missiles* | 351 | 507 | 446 | 519 | 421 | 507 |
| | Electronics/ Communications | 148 | 175 | 170 | 179 | 172 | 175 |
| NAVY | Missiles* | 553 | 498 | 619 | 566 | 427 | 491 |
| | Electronics/ Communications | 197 | 235 | 248 | 245 | 254 | 224 |
| AIR FORCE | Missiles* | 2615 | 2811 | 2833 | 2886 | 3049 | 3007 |
| | Electronics/ Communications | 618 | 692 | 799 | 740 | 637 | 679 |

** Figures do not include construction, ships and maintenance*

"The budget for the coming fiscal year, by contrast, programs more than four times as much for strategic missile systems as for manned bomber systems."

Total military obligations for aircraft procurement and R&D declined from $7 billion in FY '61 to $6 billion in FY '62. Total obligations for missile procurement and R&D dropped from $5.7 billion to $5.5 not including *Polaris* submarines.

"Manned bombers—both land based and carrier based—will continue to be required," Eisenhower said. "However with the advent of the operational missile systems more and more of the strategic forces in the years ahead will be composed of fixed base and mobile ballistic missiles—both land and sea based."

The ending of all production of B-52's and B-58's in 1962 clearly marked the change.

## Strategic Missiles

The "Big Four" strategic missile systems—*Atlas, Titan, Polaris* and *Minuteman*—received the bulk of the well over $6 billion in obligations planned for all missile programs under the new budget's procurement, RDT&E and construction accounts.

Combined obligations for the four totalled $3.9 billion. That is a $100-million increase over the FY '61 budget and $900 million over the budget for FY '60.

*Polaris* received the most: nearly $1.5 billion, including funds for the five more nuclear-powered *Polaris* submarines. The planned obligations also included nearly $400 million to support more R&D, mainly work on the 1500-mile *Polaris II* and the 2500-mile *Super Polaris*.

*Minuteman* came next, with more than $1 billion. Most of the obligations will be for procurement. Less than $150 million will be obligated for base construction.

*Titan* received just under $900 million, mostly for procurement of missiles and ground support equipment. *Atlas* received about $600 million, almost entirely for procurement.

The budget stated that the procurement of *Atlases* in FY '62 will "substantially complete" the presently-planned 13 squadron *Atlas* program. The *Titan* procurement will continue the current build up toward 14 squadrons. The *Minuteman* procurement is the first major "buy" of the big solid-propelled ICBM's.

The *Hound Dog* was the only other strategic missile to receive sizable funding besides the "Big Four." Procurement of *Hound Dogs* was continued at a relatively high level for both combat bomber squadrons and for stockpiling as part of SAC's air alert build up.

Funding the procurement of B-52 parts for launching an air alert of one-eighth of the heavy bomber force was all but completed in the FY '61 authorizations. The air alert money in the new budget would be spent mainly on *Hound Dog* components and training.

The hardest blow taken by the Air Force in the field of strategic missiles was the refusal of the Administration to include any new funding in the budget for *Sky Bolt*. The budget calls for the *Sky Bolt* to coast along through FY '62 on the remains of the $150 million which the Air Force sought to out into the program in FY '61.

However, the R&D program for the *B-70*, which is being designed to carry either *Sky Bolt* or some other ALBM, received nearly a half billion dollars. That would bring total funding of the *B-70* to about $1.2 billion.

## Tactical Missiles

All three services received sizeable direct obligational authority in the budget for the procurement of tactical missiles, ranging from air-to-surface *Bullpups* and air-to-air *Sidewinders* to the first 500-mile range *Pershings*.

The Army made considerable gains in its modernization program. The budget provided $519 million in obligations for missile procurement including, besides the first *Pershings*, continued orders of nuclear-tipped *Davy Crockets*, surface-to-surface *Sergeants* and *Little Johns* and "increased quantities" of anti-tank missiles.

Procurement of *Nike-Hercules* surface-to-air systems has ended. But the budget provided for continued purchasing of improved *Nike-Hercules* radars as well as more *Hawks* and *Redeyes* for low altitude air defense.

Overall air defense purchases were on the decline, reflecting the decline of the aircraft threat itself.

Total capital and operational outlays for air defense except for *Nike-Zeus* R&D for FY '60 were about $3.1 billion. For FY '61 they are scheduled to be about $2.8 billion and for FY '62 the new budget provided in obligations about $2.5 billion.

Total obligations that have been made available for *Nike-Zeus* R&D including the approximately quarter

*(Continued on page 42)*

# Soviets' New Budget Heavy with Arm

***Rocket research increased by 18.7%; total military expenditure appears to be from 42 to 59 billion rubles; GNP difficult to estimate***

RUSSIA'S SPACE AGE BUDGET for 1961 maintains the high level of military spending established in 1960 —with an 18.7% increase in rocket research and a 3.4% step-up in Cold War spending.

It also adds 3 billion new rubles to stimulate Soviet industry.

These increases are among many contained in the '61 spending program rubber-stamped by Soviet parliamentarians at their annual budget session. It is a record 77,589,000,000-ruble budget—4 billion more than the 1960 total.

The figure is given in the new rubles which took effect on Jan. 1. The new ruble is worth ten old ones, and the Russians officially claim that it is worth $1.11 American. It is doubtful that this ruble is less elastic than the old model.*

As always, the total budget is subdivided into five major categories. The National Economy gets 33.9 billion, or 44%, of the total. Earmarked for Social and Culture is 27.1 billion, 35%. State Administration gets 1.1 billion, and 8%—6 billion—is contained in the secrecy-wrapped Unspecified Funds category.

• **Concealed spending**—The Supreme Soviet allocated 9.3 billion to the Military departments. However, total military assets include several other activities which must be accounted for. A case in point is the "unspecified" 6 billion administered by the Committee on State Security (KGB). Most experts say the money is expended to enforce internal adherence to the Politburo line, to subsidize illicit Communist activities in foreign countries, to buy friendly officials of uncommitted or "neutral" countries, and to maintain all forms of intelligence activities.

Appearing before the assembled Soviet delegates, Finance Minister Vasily Garbuzov said that 3.8 billion was available for scientific research, which encompasses rocket development. Russian secrecy being what it is, this amount—impressive though it is—may not represent the true total.

The four-year growth in rocket research and development represents a 153% increase since their first space budget was adopted in 1958—two months after *Sputnik 1* erupted in world headlines

Russia can be expected to increase pressure on the United States and its free allies by means of space propaganda and development of large rocket vehicles and heavy payloads.

The Russians believe that their efforts to gain world supremacy are aided by achievements beyond the frontiers of space. Their budget commits them to follow their revolutionary course with all the weapons necessary to its attainment. To accomplish this, some sacrifices have apparently been forced on Russian citizens.

• **Consumer pressure**—Discontent at the ward level was reflected in questions from the delegates. Both Garbuzov and Power Station Construction Minister Ignat Novikov promised the Soviet deputies prior to the budget's approval that electrical capacity would be augmented in 1961 by 7,800,000 kilowatts. They also promised to increase supplies of home repair materials, footwear, wines, confectionery goods and chemical and electrical machinery.

It was announced that investments in principal industries would be increased as follows:

| | *1960* | *1961* |
|---|---|---|
| Iron and Steel | 20.0% | 31.0% |
| Chemical | 30.0% | 42.0% |
| Petroleum | 15.0% | 16.0% |
| Mechanical | 30.0% | 40.0% |
| Agricultural | 11.0% | 12.8% |
| Total Investments | 11.0% | 12.6% |

No itemized amounts were revealed, but overall Industry received 15.6 billion, Agriculture 3.3 billion, Local Economies 3.1 billion and Transport-Communications-Commerce 9 billion. (Industrial self-financing is estimated at an additional 24 billion.)

• **Military outlay**—There is no procurement of weapons or other war materials; therefore, no funds are allocated for this purpose. Russia manufactures its own tools of war and "buys" from itself at any price it cares to establish for bookkeeping purposes. These paper adjustments, however, are considered support costs for weapons manufacture. Various analysts, comparing these costs to armament procurement, have set the value between 20 and 35 billion.

## OFFICIAL SOVIET BUDGET

*(all figures in billions of new Rubles)*

| Principal Categories | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| National Economy | 24.5 | 25.7 | 30.9 | 31.0 | 33.9 |
| Social and Culture | 18.8 | 21.2 | 23.2 | 24.7 | 27.1 |
| Armed Forces | 9.7 | 9.6 | 9.6 | 9.4 | 9.3 |
| State Administration | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 |
| Unspecified (Espionage) | 6.2 | 5.0 | 5.9 | 6.2 | 6.0 |
| National Debt | | | | .2 | .2 |
| **TOTAL BUDGET** | **60.4** | **62.7** | **70.8** | **72.6** | **77.6** |

** Prior to the close of 1960, the USSR worked on a basis of four rubles = $1. Since Jan. 1, 1961, a new ruble has been created whose gold content gives a relation of one ruble = $1.11.*

*However, the ruble does not have any practical use in trade outside the Soviet bloc countries, and the relationship may be regarded as artificial. To some extent, Soviet authorities recognize this fact; when the official rate was 4 = $1, foreign tourists were paid at the rate of 10 = $1.*

# Spending

**by Bernard Poirier**

Social and Culture contains a second military-type activity, in addition to rocket research. This is the Physical Education portion. Funds in this innocently entitled area supposedly support pre-inductee military training and home guard fitness programs. But some observers state categorically that the whole amount has a military character.

A conservative estimate of the minimum Military category appears to be around 22 to 24.3 billion new rubles. Weapons support costs, 20 to 35 billion, should be added to this total. For purposes of comparison, the actual military effort appears to be between 42 and 59 billion:

| *Military Effort* | *1960* | *1961* |
|---|---|---|
| Direct Appropriation | 9.4 | 9.3 |
| Physical Education | 4.7 | 5.2 |
| Scientific Research | 3.2 | 3.8 |
| Espionage, etc. | 6.2 | 6.0 |
| TOTAL | 23.5 | 24.3 |

• **GNP enigma**—The Russians have never admitted any figures for their Gross National Product, and speculation on their GNP leaves much to be desired. An easy comparison between their military spending and GNP is not readily available, as it is in free countries. There is no problem in determining, for example, that U.S. Defense spending is less than 1/10th the GNP.

The Russians are on record with at least one of the factors making up a GNP total—Industrial Production. Industrial production figures should be hard or fixed once they have been determined, but the Russians' extravagant treatment of hard figures would baffle anyone. It is problematical whether a better analysis can be made of their IP claims than their nebulous budget categories.

In 1952 the Soviets claimed that their 1928 IP had been 10.5% of the U.S. IP and 32.7% in 1937. These Russian "hard" figures became hopelessly contradictory by 1957 and they were revised to 6.7% for 1928 and 24.7% for 1937.

However, in 1958 Khrushchev pulled the rug from under his statisticians by proclaiming that Soviet industrial production was pegged at half the U.S. effort. (According to the year-old 1957 revision, the 1958 IP should have been 72.8%.)

Naturally, the Soviet numbers-jugglers re-established their revision of supposedly "hard" historical figures to support Russia's latest spurious claim.

It is generally believed that the most believable IP figures were established by the Russians themselves in 1934, when their 1928 effort was described as a shade over 10% of the U.S. IP effort in 1928. Also, at least four analysts of Russian economics estimate the maximum average annual growth of Russian IP over the last 30 years as between 5.47% and 6.5%, basing their calculations on Krushchev's claim.

Others often describe Russia's GNP as half that of the United States. Therefore, their military spending would represent a greater percentage of total GNP than the United States percentage of defense spending.

From the few perceivable rays of light penetrating the Russian smokescreen over their actual budget and economy, several conclusions are inescapable:

(1) Russia commits a greater portion of its national wealth to financing military and Cold War utensils than does any free country.

(2) Russia is augmenting its annual investment in rocket research for space achievements and military potential.

(3) There is evidence that satellite bloc countries support Soviet rocket production and development to a much greater degree than any comparable cooperation exists in the West.

(4) There is no evidence of Communist redundancy of effort in rocket development—such as military versus "scientific"—or one Communist bloc country funding a rocket development while another pursues the same course.

(5) Western plans designed only to match Soviet programs are insufficient. Programs should be implemented to surpass the Russian effort by material investments and increased mutual cooperation in utilizing vast Western resources in the development of rocket technology.

(6) The annual Russian claim that their military spending has been decreased is nothing more than a subterfuge. They have annually increased military investments, international Communist programs and usurious foreign aid programs.

(7) Russia has one goal—world supremacy which denies human rights. Space propaganda is one most useful tool to this end, despite the cost. ⌗

## *Khrushchev Sees Victory Nearing*

Underscoring stepped-up military and space expenditures in the 1961 Soviet budget Premier Khrushchev now contends that victory of world communism "is no longer far off." He adds that war is not necessary to victory.

However, war will come, he warns, if capitalist nations try to resist the "inevitable" Communist victory. Khrushchev bore out Western interpretations that the Soviet budget was heavily weighted toward a military build up by saying that "the USSR will increase the military might of our country since the imperialists are continuing the arms race."

In a 20,000 word speech delivered Jan. 6 to a general meeting of Party organizations in Moscow, and made public last week, the Soviet Premier claimed that the imperialists are preparing war and "our task is to raise insurmountable obstacles."

He cited his policy of "peaceful coexistence" as accomplishing his purpose. "It facilitates the activities of the Communist Party and other progressive organizations of the working class in the capitalist countries, makes it easier for the peoples to combat aggressive war blocs and foreign military bases and contributes to the success of the national liberation movement."

The Soviet premier claimed that "the imperialists have in recent times failed to draw a single new state into their military bloc.

"In recent years the initiative in the world arena has belonged to the Soviet Union and other Socialist countries, while the imperialist countries and their governments have had to keep on the defensive. Their prestige and international rating are lower than ever."

Khrushchev said he would be opposed to brushfire wars which might lead to world conflict, but pledged to support uprisings of "national liberation" such as in Algeria.

The question of West Berlin, Khrushchev said, "has done much to unmask the U.S.A., the Federal German Republic and other NATO countries as opponents of a relaxation of tension."

If these countries refuse to reckon with the "real situation," the Soviet chief threatened, "we shall take resolute measures.

"We shall sign a peace treaty with the (East) German Democratic Republic." ⌗

# Drive to Better U.S. Space 'Image'

## Wiesner committee report foretells effort to restore prestige; highly placed official stresses urgency

by Jay Holmes

PRESIDENT KENNEDY can be expected to give much more weight to the U.S. image abroad in planning the U.S. space program—particularly man in space.

Former President Eisenhower consistently rejected considerations of national image and prestige. His last statement on the subject, in his budget message last week, declared that further testing and experimentation were necessary to establish "whether there are any valid scientific reasons for extending manned space flight beyond the *Mercury* program."

The retiring President thus rejected arguments, put forth by some advisers at the highest levels of the government, that there are other reasons than scientific for exploring space.

A tip on the attitude of the new administration is given by key sentences in the report of the Ad Hoc Committee on Space, headed by Dr. Jerome B. Wiesner, Kennedy's chief scientific adviser. The committee, listing motivations for desiring a vital, effective space program, said:

"First, there is the factor of national prestige. Space exploration and exploits have captured the imagination of the world. During the next few years the prestige of the United States will in part be determined by the leadership we demonstrate in space activities. *It is within this context that we must consider man in space.*" (Emphasis supplied.)

Eisenhower heard and rejected similar arguments at meetings of the National Security Council, which sets policy at the highest level in the government. At the second tier, such reasoning was turned down in the Operations Coordinating Board, which is responsible for carrying out policies.

• **Unanswered pleas**—It now can be told that high officials concerned with America's image about the world pleaded repeatedly with Eisenhower and budget-minded members of the inner family to support space exploration more enthusiastically.

"It isn't just that we're in a race with the Soviet Union," said one official familiar with the NSC and OCB discussions. "We want to give the impression of naturalness and vitality in our program. We want to show a picture of an America that wants to send men into space because of the real challenge in doing it, to take up the toughest challenge."

The high official gazed about his spacious office and remarked, "You know, we're reaching the stage of a closed world. Navy aviators have flown over the last of the Antarctic. All of the mountains have been climbed. Africa has been explored. The world is almost turning into one vast series of suburbs. There isn't much challenge left here on earth for an adventurous young man."

He listed the "impression of naturalness and vitality" in the image abroad as the primary justification of the U.S. space program. Scientific value was second and the "so-called race with the Soviets" as third in importance.

• **'A long-term thing'**—"If Khrushchev should call off the Soviet space program tomorrow, I still think we should explore space," he added. "We might reconsider the spending rate, of course.

"If the picture got out that we don't care about space but just want to stay in competition with the Soviets, it might do more harm than good."

The high official emphasized the necessity of full-speed work on *Apollo*, the three-man spacecraft designed to follow *Mercury*. "If we simply put a man into space in *Mercury* style and then stopped," he said, "it would be self-defeating, merely a stunt. Space exploration is a long-term thing."

Above all, the official counseled against an appearance of panic and scrambling. "We should have a well-thought-out program. We should not look scared and uncertain," he remarked.

What about the effect of military participation in space programs on America's image? "It doesn't solve the problem to pretend that Project *Mercury* is a purely civilian exercise," he replied.

"The astronauts are military men. One of them is about to perform an exceptional feat of bravery—certainly comparable to heroism under fire or saving a comrade's life."

The official was asked whether there had been any difficulties in negotiating tracking stations abroad because of an impression *Mercury* was military.

"There was a little at the outset," he replied. "But *Mercury* is now well understood around the world. There is no problem now."

• **Retoring prestige**—The new administration is also expected to give careful study to a lengthy report of Eisenhower's Committee on Information Activities Abroad, headed by Mansfield D. Sprague.

The report, released Jan. 12, called for increased information work in all fields, including science and technology. The report, finding that launching of the *Sputniks* gave the Soviet Union "a psychological triumph which has profoundly affected its image as a technologically advanced nation and a great military power," said it will not be easy to re-establish American technological prestige "short of some revolutionary scientific breakthrough."

The committee recommended:

–Increased efforts to communicate U.S. scientific achievements to both scientists and the general public abroad, by recruiting and training of information specialists competent in technical subject matter.

–Organizational measures to give new prominence to science in government.

–Expansion of programs for teaching and transmitting American technical knowledge abroad.

–Encouragement of joint scientific programs with other countries of the Free World. ⌗

## Adm. Burke to Receive 1960 Silver Quill Award

ADMIRAL ARLEIGH A. BURKE, Chief of Naval Operations, will become the 11th member of the Society of the Silver Quill on Jan. 27, when he receives the 1960 Silver Quill Award at the State of the Nation Dinner in the Sheraton-Park Hotel in Washington.

The Award is presented annually by National Business Publications, Inc. "for most distinguished service to business and industry." ⌗



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## Schriever Tells AAS Of Coming Space Blueprint

The Air Force is getting ready to produce a blueprint for a long-range space program.

Lt. Gen. Bernard Schriever revealed that a space study committee—including three members of President Kennedy's ad hoc space committee—will report next month to his Air Research and Development Command. ARDC will make recommendations to the Air Force on the basis of the study.

The committee is expected to detail the means of obtaining a strong military space capability.

"I am not convinced that we have done everything possible militarily in space," Schriever told a meeting of the American Astronautical Society in Dallas, in disclosing the forthcoming report. "I am convinced they (Russians) will use space for military purposes as soon as it is to their advantage to do so."

"Our military requirements for space will not be completely satisfied by the developments underway or planned in our civilian programs. The military and civilian missions in space do not merge into the single image," the ARDC chief said.

Asked if a fourth service might be necessary, Schriever retorted, "We have enough trouble with three—why create a fourth?"

"Today we have a major effort in bio-astronautics, the man-machine relationship and its application in the *X-15* and *Dyna-Soar* programs. I would like to point out the Air Force has the resources and has marshalled them for today's aerospace age. We have been planning and building ahead. Resources for our military mission in space already exist."

Other highlights of the AAS' seventh annual meeting:

• **Dr. Wernher von Braun,** Director of NASA's Marshall Space Flight Center said that Project *Rover* will probably be best used in deep space probes, around the moon or Mars, because of "obvious political aspects" of nuclear propulsion.

• **Dr. Fred L. Whipple,** Smithsonian Astrophysical Observatory head, disclosed finding that the moon is bombarding the earth with high velocity particles of dust. "Moon dust" is gathered in a halo about 100 miles above the earth before it drops to the ground. This will pose additional hazards to man in space.

• **Dr. Charles F. Gell,** Life Sciences Chief for Chance Vought Corp.'s Astronautics Division, warned that men returning from trips to other planets may possibly bring with them parasites that could overrun the earth. ⌘



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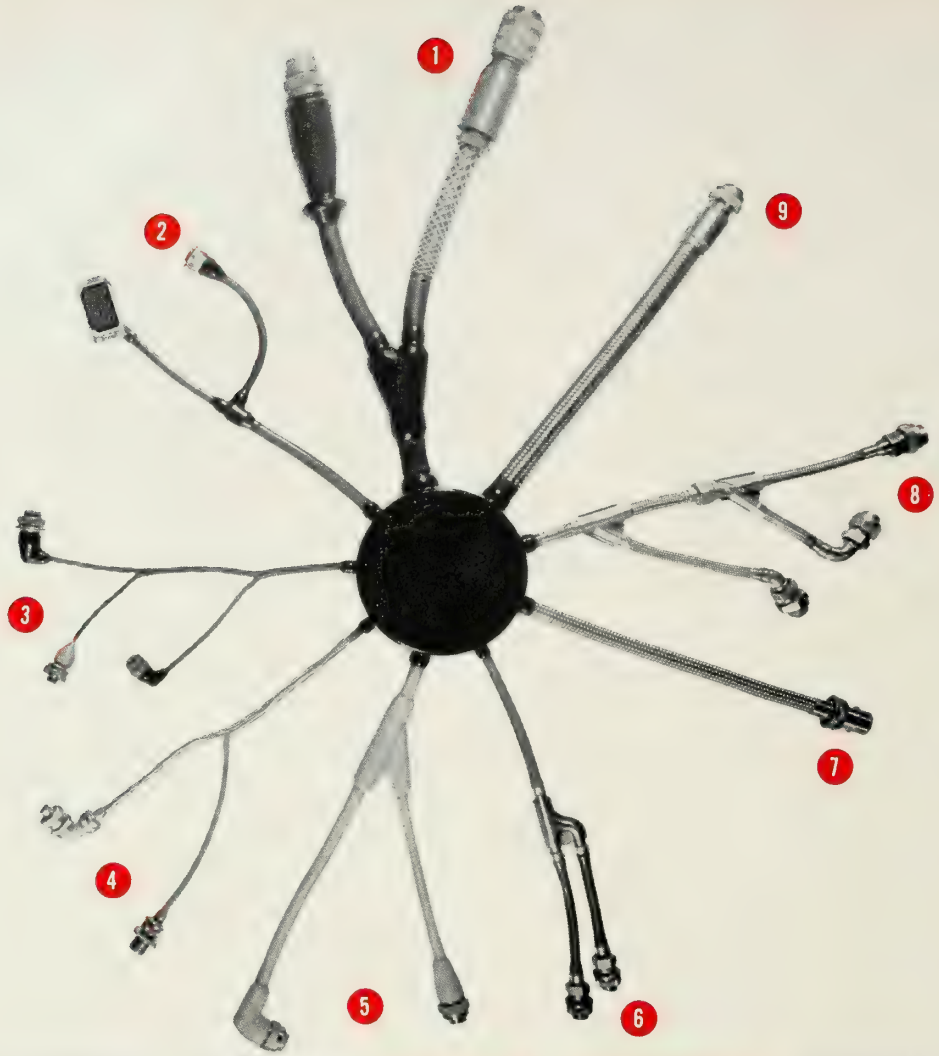
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# Technical Countdown

## ELECTRONICS

### Epitaxial Transistor Prices Cut

Prices of epitaxial transistors—which first went on the commercial market only about three months ago—have been reduced 25% by Sylvania. Encouraged by industry acceptance of the epitaxial units, Sylvania plans to add silicon and additional germanium mesa types to its present line.

### British Military Electronics Imports Increase

First-half of 1960 imports of communications, navigation, and radar equipment from Britain were up 59% over the preceding six months, the Department of Commerce reports. Money value was $1.5 million. Imports of commercial electronic equipment, however, fell off considerably—contributing to an overall decrease for the first time in over a decade.

### 'Siamese-Twin' Transistor Developed

A new twin transistor developed by RCA is reportedly capable of boosting the voltage of low-power sources up to 10 times. One proposed application would be for amplification of solar-cell power in space vehicles. First available model of the solid-state device will be a DC chopper-amplifier, expected on the market in about two months.

### Low-Cost Track-While-Scan Developed

Servonics, Inc., has successfully produced and tested a system that can be used to modify almost any existing search radar for automatic track-while-scan operation. Costing roughly $1000 per tracking channel, up to 120 channels may be used with a single system, the company says. The system uses analog techniques. (See p. 29 for details.)

## ASW ENGINEERING

### Penn State Takes Over ASW Center

Pennsylvania State University has assumed management of the Navy's ASW research center in LaSpezia, Italy. Raytheon managed the joint Navy-NATO center until the first of this year.

## SUPPORT EQUIPMENT

### Advent to Have Shipborne Terminal

A seagoing satellite communications terminal will be built by Navy for use with Army's 24-hour *Advent* relay satellite. The shipboard terminal will operate at many different parts of the globe to test the satellite's capabilities and provide data on fringe area operations. First *Advent* launch is scheduled for early 1962.

### WSMR Adds Spectra Analysis Gear

A new spectral comparator computer has been installed at White Sands Missile Range for analyzing and automatically identifying the presence of certain characteristic r-f spectra in a low-frequency spectrum. Built by Delco Radio, the equipment includes a display console that shows the percentage match of selected frequency-intensity characteristics compared to spectra stored in the computer.

### Missile Safety Course Begun by AF

U. of Southern California last week began the world's only course in the safe handling of ballistic missiles. The eight-week course, conducted under contract with the Air Force, is aimed at producing professionally trained missile safety experts. "Lab" materials include the aft end of the *X-15* which exploded in static test last June.

### Telemetered Data Reduced During Flight

Information telemetered from a research rocket over White Sands Missile Range recently was successfully reduced to final form simultaneously with its reception on the ground. The Ortholog analyzer, developed by Gulton for ARGMA, handled five channels of wide-band data. Gulton claims the equipment permits a 1000X reduction in telemetering channel capacity, with a consequent saving in airborne transmitter power.

### AMR Ship Contracts Out For Bid

Contract award for the $50 million conversion of two C-4 ships for the Atlantic Missile Range is expected in June. As anticipated, competition is hot and heavy; many companies are forming teams to pool resources on the bidding. Bidders will likely include Sperry, Martin, Electric Boat, Raytheon and RCA. There is some conjecture that the ships, when completed, may also be used at PMR.

### NTC to Include European Experts

This year's National Telemetering Conference (Chicago, May 22-24) will include a panel of European experts who will outline progress and development in telemetry in their respective countries. In order to bring the group to the U.S., the AF Office of Scientific Research plans to underwrite travel expenses. Many U.S. experts feel that our European allies have made significant progress in telemetry and an interchange of data would be beneficial. Plans to further broaden the international scope of NTC include scheduling of the 1963 meeting in London.

## ADVANCED MATERIALS

### B-70 Auto-Ignition Hazards Eliminated

A liquid nitrogen system will maintain constant pressure and atmosphere in the Mach 3 B-70 bomber's fuel tanks while in flight. The cryogenic inerting system is the brainchild of Arthur D. Little, Inc., and Parker Aircraft Co. North American is currently running simulator tests on the protection system. Altitude and speed of the big bomber make such a system necessary.

### Largest Vacuum-Melt Furnace in Operation

Allegheny Ludlum has commenced operations with a vacuum-melt furnace capable of producing ingots 50 in. in diameter and weighing up to 30 tons. Lectromelt Division of McGraw-Edison Co. built the unit.

## PROPULSION

### Tory II-A Gets Impact Test

A railway flat car carrying the Tory II-A test vehicle, without its reactor core, broke away from its locomotive last week at the AEC *Pluto* Test Area, rolled 200 feet down an incline, and ran into the massive concrete outer wall of the *Pluto* test bunker. Damage to bunker-vehicle connections was estimated at several thousand dollars. Necessary repairs will probably cause some delay in the current test program, but just how much may not be known for some time.

### Venus P-37 Scatched

Former NASA Administrator T. Keith Glennan's stretchout of the NASA program cancelled plans for launching P-37, a Mariner spacecraft to go aboard the seventh *Centaur* vehicle toward Venus in the last half of 1962. Best dates for a Venus launching in 1962 will be Aug. 10 to 16. P-37 now will be merely a spacecraft test.

# Sputnik V Shows Soviets' Know-how

***Results show Russians can now build space environment acceptable to human beings***



*IMAGES OF test dog Belka relayed by a radio-TV system installed in Sputnik V show that resolution was adequate for monitoring purposes. Photos by Camera press.*

*THE FOLLOWING ARTICLE was abstracted from* DISCOVERY, *a British science magazine. It details Soviet technical descriptions of the experiments reported to be aboard Sputnik V, which make it the greatest achievement so far in the annals of bioastronautics.*

*Orbiting and return of this life support capsule five months ago has led U.S. space experts, among them Brig. Gen. Don D. Flickinger, ARDC bioastronautics chief, to believe that Russia has a 3-5-year lead in space medicine.*

*Sources of the material in the article were drawn by* DISCOVERY *from translations of articles appearing in Isvestia and Pravda.*

On Aug. 19, 1960, the USSR sent a 4.5-ton spacecraft into a slightly elliptical orbit between 190 and 211 miles above earth.

After approximately 27 hours of weightlessness and exposure to space conditions, the Soviets reported, reentry was triggered on the 18th orbit and the capsule was returned. All animal occupants were reported alive and the capsule in "good enough condition to be used again."

In addition to the famous dogs Strelka and Belka, there were 40 mice, several hundred *Drosophila* fruit flies and a score of smaller experiments on the microbiological, plant and cellular level.

The Soviets showed a high degree of sophistication in both the experiments and the environment they provided for them—one which would certainly be acceptable to human occupation.

• **Atmosphere**—Oxygen concentration was maintained at 20% to 25%, $CO_2$ no more than 1%, temperature between 59°F and 77°F, relative humidity 39% to 70%, pressure one atmosphere. (Most U.S. projects call for ½ atmosphere.)

The Soviets noted that the animals would have been capable of withstanding wider variations in the environment; they wished to minimize the strain from extreme environmental conditions to leave a margin for strains of high accelerations, weightlessness, etc.

The air was cleansed by active chemical compounds of harmful admixtures and water vapor resulting from the activity of the animals and equipment. The dogs consumed about 8-9 liters of oxygen per hour, exhaled 6-7 liters per day, plus ¼ liter of water.

During flight the dogs were periodically fed by an automatic feeder containing a jelly-like mixture which supplied both food and water. The Soviets reported that the dogs did not feel thirsty or lose weight on the mixture

but required considerable pre-conditioning to get used to the new food. The mice were supplied dry briquetted food and moisture from pipes.

• **Canine experiments**—Strelka and Belka are two sturdy mongrels who had undergone considerable pre-flight training. Before launch the dogs were subjected to an operation which brought the carotid artery to the surface of the neck in a flap of skin. Electrodes were placed under the skin to get EKG (electrocardiogram).

Respiration frequency, body temperature and movements were recorded during flight and correlated with films made from the television monitor. The Soviets claimed they recorded arterial blood pressure but did not disclose how.

Data transmitted to earth stations by radio telemetry (with a memory unit to store data when the satellite was out of range for later transmission) included cabin temperature, pressure, humidity and control data on the functioning of the life support systems.

• **Television**—The Soviets received a continuous television broadcast from the vehicle, which in turn was filmed at ground stations. The scientists said they chose TV instead of a high-speed camera since the equipment took less space and required less light.

Transducers mounted on the dog's cradles provided additional information on the movements of the animals. Ionizing radiation dosimeters were placed near the dogs and on their suits.

The 21 black and 19 white test mice were also thoroughly studied before the flight, according to Soviet reports. Blood tests and electrocardiograms were taken before and after flight. Careful studies were made of the higher nervous activity and typological peculiarities and compared before and after.

• **Results**—Preliminary examinations reported in November disclosed no permanent effects from the flight. Pre- and post-flight metabolism tests, albumen content and certain ferments and hormones of the blood and urine were normal after flight.

Cardiovascular studies were made to see if the heart and peripheral blood vessels were affected by radiation, weightlessness or acceleration. Immunogolical reaction of the dogs was studied to see if radiation or flight conditions lowered their natural immunities to microbes.

Deep bone-marrow tests are being made on the mice to see if the radiation dose had any effect on their blood-making activity, but results have not been released.

• **Other experiments**—The microbiological and cytological specimens placed aboard the vehicle were in general well known strains familiar in laboratories throughout the world.

Fifty cartridge cases contained sealed ampules of cultures of intestinal bacteria (type KK-12B, "aerogenes"), butyric fermentation bacteria, a culture of staphylococci, two varies of phages (T-2 and 13-21), and desoxyribonucleic acid.

The desoxyribonucleic acid (DNA) solution was included in the experiment because this chemical, found in the nucleus of cells, participates in the transmission of genes from generation to generation. Soviet scientists feel that no serious devastations will be found in the recovered sample because it was exposed to the radiation in space for a relatively short time. They are looking for delicate changes with physical-chemical, immunological and other techniques.

Human cancer cells (He-La cells) were used since they grow well in artificial media and are widely used in studying genetic problems and the nature of cancer. They will be compared with control cultures which remained on earth.

The satellite also carried small pieces of human and rabbit skin. The human skin was donated by Soviet scientists and plans are to regraft the skin on the donors to determine the effect of space conditions on sensitive cellular systems.

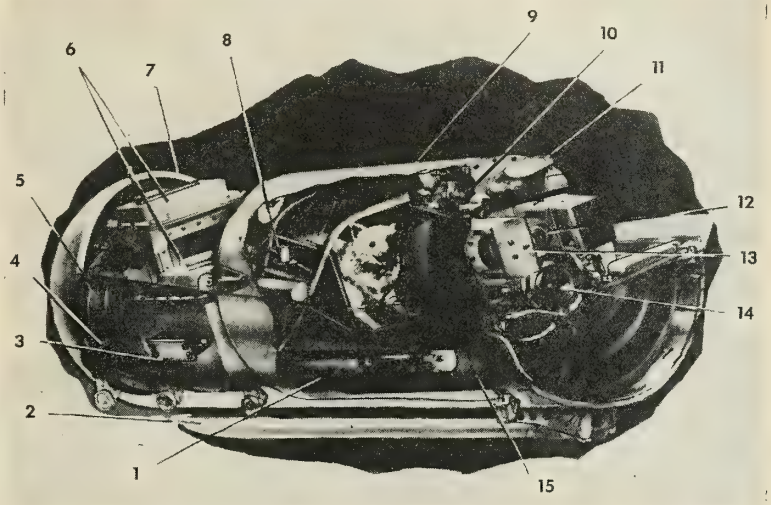
• **Micro-organisms** — A container carried four automatic bioelements with a culture of butyric fermentation bacteria, two enclosed in a special thermostat and two in an unheated container.

These butyric fermentation bacteria were placed in the satellite to work out methods of automatically recording and transmitting the vital activity of micro-organisms. Such methods will make it possible to determine the period of survival of cells in spaceships making long flights and not returning to Earth. Soviet sources state this experiment "has fully justified itself."

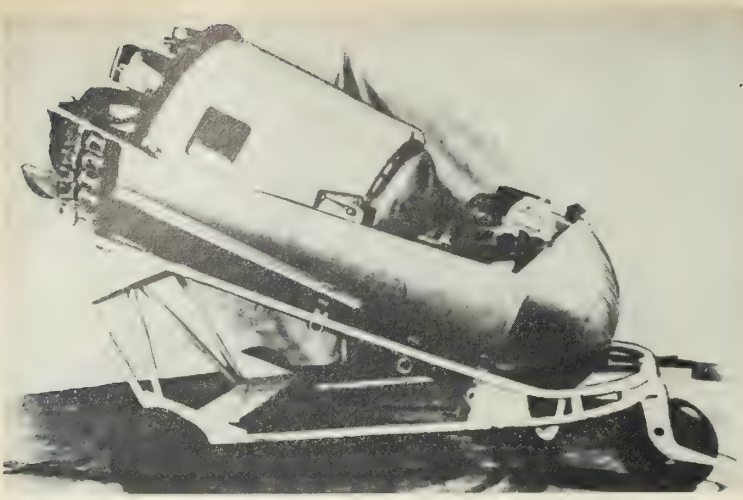
The fruit flies, well-studied in laboratories, should be an excellent subject to discover mutations caused by radiation. Two lines were used in *Sputnik V*, the D-32 with a low mutability under natural conditions, and the D-18 with a high natural mutability. Crossing experiments are now being carried out to determine the frequency of the most important types of harmful mutations.

Since ionizing radiation is extensively used to obtain new strains of Actinomyces (which provides penicillin and streptomycin), two strains of fungi —producers of penicillin—were placed in the satellite. Results have not been reported.

Special vessels with the unicellular alga *Chlorella* in liquid and solid nutritive media were carried. This experiment may prove particularly valuable since algae may be used in future spaceships in the recycle of air or for food. Studies are now being made of the morphology




*CUTAWAY VIEW of Sputnik V cabin shows: 1) Air supply tank; 2) Ejection firing device; 3) Radio-bearing unit; 4) Battery for heating test tubes containing microbes; 5) Storage battery; 6) Scientific instruments; 7) Shell of instrument section; 8) Transducer to measure animal movement; 9) Shell of animal section (pressurized); 10) Microphone; 11) Aerial for radio-bearing unit; 12) TV Camera; 13) Mirror; 14) Ventilator, and 15) Automatic feeder.*



*CATAPULTING CONTAINER of Soviet space ship. The animals' cabin is at the right in the photograph. Photos by Camera Press London.*

of the exposed cells, the photosynthetic activity, the growth process, and the changes in heredity.

Other vessels contained *Tradescantia* plants, the seeds of different varieties of onions, peas, wheat, maize and *Nigella*. Plants with buds were used since it is easy to observe chromosome rearrangement in plant cells that are dividing at the time of pollen formation. The seeds will be planted to see if mutations occurred.

• **Cosmic ray experiments**—The wording used in Soviet reports concerning an experiment designed to obtain data on the ratio of nuclei of the carbon-nitrogen-oxygen group to those of the lithium-beryllium-boron group makes it appear that the experiment didn't work.

The satellite also carried an integrating Cerenkov counter for measuring streams of heavier nuclei. Soviet reports claim the successful detection of tenfold increases in the intensity of streams of nuclei having a charge of more than 15, and correlated these bursts with the radio emission from the Sun. This was the first time relativistic heavy nuclei have been observed originating in the Sun, the reports stated.

Several (probably four) heavy-layer emulsion blocks were sent in the vehicle, one of which was developed on board after about 10 hours. This was apparently to ensure that tracks from rear particles would not be lost in an accumulation of tracks from more common particles.

One of the emulsion packs is described as an FE-2 block to record elementary nuclear interactions of high-energy particles of the order of $10^{12}$ electron-volts or more. It consisted of a 10 cm. square stack made up of alternate layers of emulsion (400 $\mu$ thick) and lightweight "target" material (1 mm thick).

The emulsion and the target material together served to register the interaction of high-energy nucleons with the heavy atoms in the emulsions and the light atoms in the target metal. The neutral pi-mesons produced by the high-energy particles gave rise to photon showers, which were recorded on a detector above the stack.

The detector consisted of seven thin lead plates with layers of emulsion and fluorescent avalanche indicators sandwiched in between. This experiment is expected to provide some fundamental information on the interaction of primary cosmic-ray particles with light and heavy nuclei.

The satellite also carried F-1 and F-2 nuclear emulsion units, each with a volume of 0-8 liters. Two gas counters and two scintillation counters were included to measure the variability of the radiation belts.

• **Solar radiation**—Two instruments studied the shortwave radiation of the sun. The first had six receivers to increase the probability of solar radiation falling on one (but never more than one) at any orientation of the satellite.

They were probably arranged in pairs, back to back, along three mutually perpendicular axes. The receivers were windowless electronic multipliers. Placed in front of each was a disc holding seven filters that was shifted around so that each of the filters was positioned in front of the electrodes in sequence, at one second intervals.

The first filter let the 1.4 to 3 Å band of radiation through, the second passed everything under 12 Å, the third passed the 8 to 20 Å band, the fourth passed the 44 to 100 Å band, and the fifth singled out the 1216 Å Lyman-*a* hydrogen line. The sixth made it possible to measure the continuum radiation in the region of the Lyman-*a* line, blocking much of the 1216 Å radiation and thereby allowing a more accurate Lyman-*a* determination from the reading with the fifth filter; the seventh passed radiation with a wavelength of more than 1500 Å to estimate the change in angle of the satellite relative to the Sun. The second instrument for studying short-wave solar radiation was designed to measure the intensity of soft x-rays emitted from the corona near the short-wave cut-off of the normal spectrum, primarily during flares. Measurements were made in two regions of the spectrum—3 to 6 Å and 6 to 10Å.

For each there were six counters (a total of twelve) grouped in three blocks. Counts were stored in a memory unit until they could be transmitted to Earth. A system of magnets and diaphragms was placed in front of each counter to deflect the electrons in the great radiation belt that would otherwise produce spurious effects.

The short-wave solar radiation detected with these two instruments is to be compared with ground observations of the ionosphere, visible chromosphere flares and other phenomena connected with the activity of the Sun to see if the processes observed in the outer layers of the Sun can be correlated with those occurring in the Earth's atmosphere.

• **Sputnik VI**—On Dec. 1, 1960, the Soviets attempted to duplicate their success.

The official Moscow Radio said, "By this time (noon, Dec. 2) the planned program had been accomplished for testing the design of the ship with the systems installed in it, the medical biological research and also the planned volume of outer space exploration.

"The information obtained yielded new data for manned space flight in the near future.

"After obtaining the necessary data, the signal was given for the return of the space ship satellite to the earth.

"Since the space ship descended along a noncalculated trajectory, it burned out on entering the dense layers of the atmosphere."

Aboard this flight, third in a series of "space ships" apparently preceding manned flight, were two dogs—Pchelka (Little Bee) and Mushka (Little Fly). The first flight in the series occurred on May 15, 1960, and reportedly carried no living creatures.

Meanwhile, an Army Lieutenant Colonel at the U.S. Industrial War College quoted "unofficial but reliable" sources as saying the Soviets had attempted and failed twice to launch manned capsules. The "Cosmonauts," he said, perished in re-entry. There has been no official statement on this report. ⌘

# ASTRO-ROCKET

*subsidiary*

## TALLEY INDUSTRIES, INC.




4551 East McKellips Road • Mesa, Arizona

# Capabilities:

ASTRO-ROCKET'S facilities and personnel are available for work in all phases of solid propellant rockets, rocket motors, propellants, gas generators, firing heads, plus all types of cartridge actuated devices. During their professional careers, our scientists and engineers have been responsible for the design, development and manufacture of over 300 devices in these categories. These devices use both high and low energy solid propellants developed and manufactured at our Mesa, Arizona facility. Solid propellants, ignitors, inhibitors and insulating materials that advance the state-of-the-art, are continually being developed by our Research and Development people. Cartridge actuated devices such as Rotary Actuators, Rocket Catapults, Firing Heads and Linear Actuators currently are being developed and manufactured at this facility.

Our Research and Development section recently developed a technique by which ammonium nitrate propellants can be cast directly into rocket motor cases, thus substantially reducing manufacturing costs for this type grain. This propellant is now in production at ASTRO-ROCKET.

# Personnel:

Mr. F. G. Talley, President of Talley Industries, Inc., parent company of ASTRO-ROCKET has gathered together a group of acknowledged experts in their fields. These men head the well qualified technical and administrative staffs at ASTRO-ROCKET.

President of ASTRO-ROCKET is G. E. Hirt, regarded as the foremost engineering authority of ballistic devices. Mr. Hirt has received many patents for work which he has done in the fields of Ballistics and Rocketry.

Dr. David A. Fletcher, Vice President and Director of Research, is known for his work in the fields of rocket fuel formulations, adhesives, and polymers. At this time he holds both United States and foreign patents for work done in these fields.

George Graf is Production Manager for high and low energy solid propellants. Royce M. Strickland, as Chief Engineer, is responsible for the development and testing of all company programs.

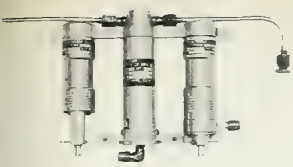
The professional proficiency of all personnel enables ASTRO-ROCKET to seek new and better ways to broaden the application of solid propellants and ballistic devices for the Aircraft, Missile and Space industries.

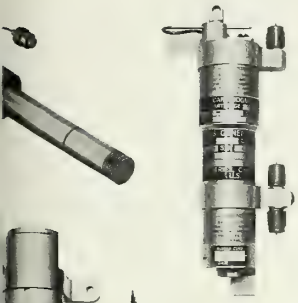
# Facilities:

The main facility is housed in a new 27,000 sq. ft. building on a 40 acre tract in Mesa, Arizona. Within this building are housed manufacturing, engineering, propellant laboratories, administration and executive offices.

Adjacent to the main building is the test range, completely equipped to test, instrument and record data necessary for the development and qualification of rocket motors, propellants and propellant actuated devices.

The propellant facility is housed in a separate reinforced concrete building and is completely equipped to grind, mix, cast and cure both high and low energy solid propellants.

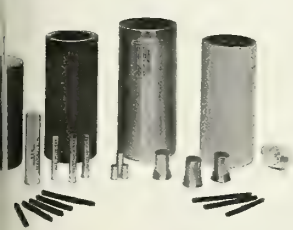






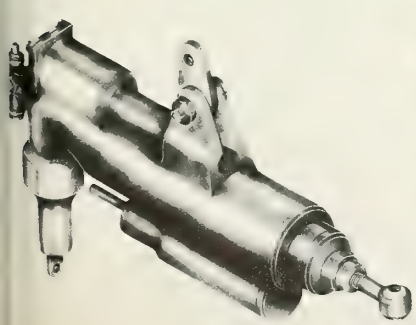


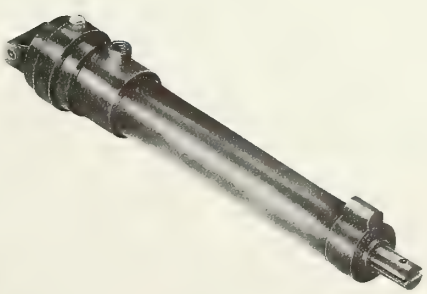


ASTRO-ROCKET is currently producing both high energy ammonium perchlorate and low energy ammonium nitrate composite propellants. These propellants are presently being utilized in rocket motors and cartridge actuated devices being produced at our Mesa, Arizona facility. A few are listed below:

GAS GENERATORS . . . currently being produced to provide high pressure gases for the pre-ejection and recovery system actuators for the B-58 *Emergency Escape Capsule,* to provide low pressure-low temperature gases for *Auxiliary Power Units, Hot Gas Servo* systems for *Thrust Vector Control* and cartridges for *Aircraft Cartridge Starters.* Gas generators are often used in applications where a high energy to low weight ratio power source is required. This, combined with their inherent immediate response, upon command, makes them an ideal power supply for a variety of applications. Gas generators can be initiated electrically, mechanically or pneumatically. BALLISTIC ROTARY ACTUATOR . . . produced for installation in the B-52, B-58, T-38, CF-104 and JF-104 for positive man-seat separation after ejection. It has been tested by the Royal Australian Air Force for the F-86 aircraft and by North American Aviation Corp., for the F-100 aircraft. Ballistic Rotary Actuators are used also as a fast safe means of positioning a crew member prior to ejection, or as a fast positive way of retracting a missile umbilical cord at "launch." It is ideal for any application where Uni-directional-rotary Actuation is needed. ROCKET CATAPULTS . . . combine a solid propellant rocket engine with a gun type catapult. This combination, one-piece unit, is used to eject seats or escape capsules, thereby providing a ground level escape capability. Rocket catapults can be utilized where it is desirable to impart a high velocity to rockets through a short launch stroke. CANOPY ACTUATORS . . . normally operate as electro-mechanical, hydraulic or pneumatic actuators, and are operated ballistically to jettison a canopy in the event of an emergency. Combination units such as these can be used in an application where normal operation is cyclical. In the event of an emergency condition or normal power failure where fast positive actuation is required, the ballistic portion will then override the normal actuating mechanism.









ROCKETS . . . used for sounding, gathering meteorological data, chaff dispensing and as booster rockets, our rockets have been designed to utilize ASTRO-ROCKET'S castable ammonium nitrate propellant. Using the "cast in case" method permits the use of complicated core configurations at a substantial cost reduction over the usual methods of extruding ammonium nitrate propellants. LINEAR ACTUATORS . . . probably the largest propellant actuated device to utilize ASTRO-ROCKET'S ammonium nitrate propellant is manufactured at our Mesa facility. This unit was designed, specifically, to effect the rapid removal of an ICBM's massive silo lid.



**ASTRO-ROCKET SERVES:**

Boeing Airplane Company, Seattle • Boeing Airplane Company, Wichita
Canadair Limited, Montreal
Convair, Fort Worth • Lockheed Aircraft Corp., Burbank
North American Aviation Corp., Los Angeles
Norair, Division of Northrop Corp., Los Angeles
Royal Australian Air Force • Stanley Aviation Corp., Denver

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**ASTRO-ROCKET**

4551 East McKellips Road • Mesa, Arizona

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WOodland 4-2981

# Servonics' TWS, Highly Versatile System

## *Army, Navy and FAA may buy low-cost matching of search and track to present radars*

by Charles D. LaFond

A SUCCESSFUL MARRIAGE of automatic search and track capabilities within existing search-type radars is now believed to have been consummated.

Cost of this union will be roughly $2000 for each tracking channel, says Servonics, Inc., developer of the new Track-While-Scan System (TWS). Up to 120 tracking channels can be introduced in a single search system, its developers say.

The significant feature of TWS is that it is adaptable to almost any existing plan-position indicator (PPI) without circuit change in the indicator. Thus most military (or civil) search (scan) radars can be modified to provide accurate tracking by adding TWS channel circuits.

Weighing about 8 pounds, each circuit occupies approximately a 3 x 7 x 20-inch package. Banks of six can be grouped for installation in standard 19-in. racks. A complete system may employ up to 20 banks of tracking units.

Each channel operates completely independently from all of the other circuits. Operational usage, according to Servonics engineers, is expandable, so that system outputs could be employed singly or in any combination for:

1) Automatic tracking (the principal design purpose).
2) Presentation on a summary plot or other automatic tracker.
3) Input to a target intercept computer.
4) "Clear Scope" presentation of composite radar observations on a TV-type indicator.
5) Input to data-link terminal equipment (for exchange of target information with other command centers).

• **Previous incompatibility cited**—Most of today's operational radars fall into either of two functional groups: search (scan) or track, each with special capabilities and limitations. They are complementary systems.

Scanning radars sweep a relatively large area and detect most of the targets within a given range. However, such systems do not retain target images on their screens with any consistency. Radar operators are unable to follow more than a few targets during each sweep—and these for only a short time.

The result is that accurate measurement of position change and speed of any particular target is improbable at best.

To compensate for human inadequacies in interpreting search observations, digital techniques have to be introduced to provide automatic tracking with scan-type radars. Target data are reduced to binary form, so that a continuous target track with simultaneous rate information is provided to the operator.

Servonics feels that the problem inherent in such approaches is the dependence on data received in serial form—which may or may not be correct. If it is incorrect, error effects tend to be compounded. But the company's most serious objection is the cost of such methods, which have been estimated (very roughly) at $50,000 per target in automatic tracking.

Even in manual rate-aided tracking (with scan radars), the human link is the significant limiting factor. In this approach, an operator continually repositions target-identifying symbols over the radar screen blips. With this method, position and rate data can be developed to an accuracy commensurate with the operator's ability and experience. For good accuracy, however, the number of targets being tracked at one time must be minimized.

To provide the best tracking information, therefore, either fewer channels must be observed or more operators must be employed. The former solution reduces system efficiency, the latter increases personnel and equipment logistics—with accompanying support problems.

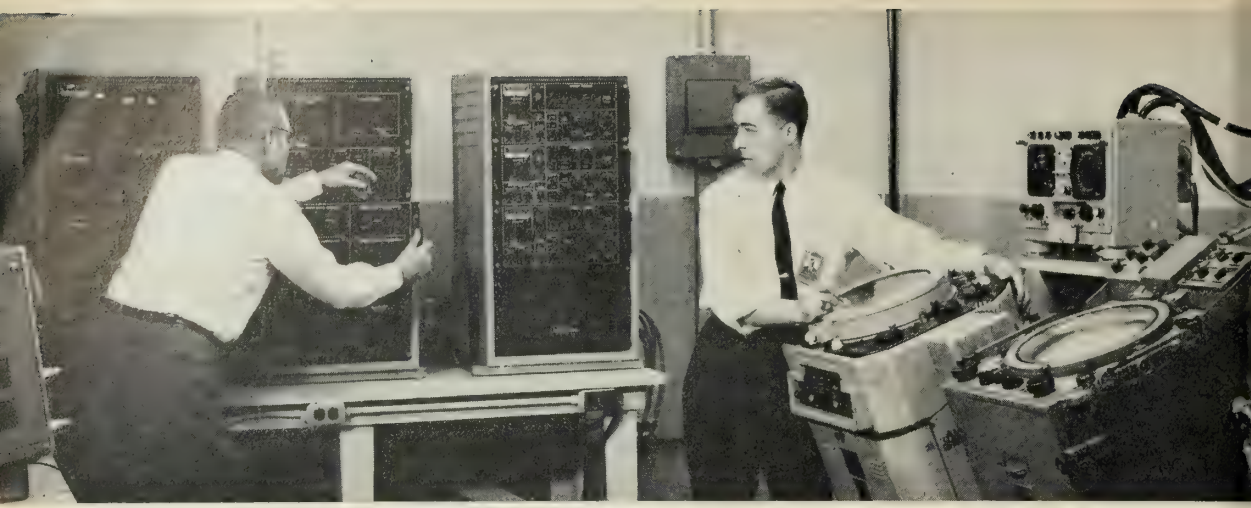
Today's tracking radars pose a completely different problem. These track continuously and with excellent accuracy, but only one target at a time. For a single target, the system is reasonably economical where high-cost weapons must be controlled.

But to introduce a tracking radar for each possible track would again involve staggering costs. Nevertheless, this is exactly what has been done in sensitive areas—simply because there was no better alternative.

• **TWS is fresh approach**—Servonics feels that its new system is a fresh approach to the use of scanning radars for automatic tracking. It is not considered a crutch to upgrade manual rate-aided tracking or a parallel approach to digital computing systems; TWS was designed to use proven and yet economical analog techniques with existing equipment. Modification costs are modest, the



*'BRIGHT DISPLAY' of selected target being tracked by Servonics' Automatic Track-While-Scan. Indicator at bottom is standard PPI.*



*ENGINEERS ADJUST the AN/SPS-T2A Radar Target Simulator used to test the TWS system.*

company believes, and added space requirements are relatively small. The accuracy of position and rate data obtained from TWS is believed to be comparable even to tracking radars and more accurate than high-cost digital techniques.

The design concept is straightforward and aimed directly at the search/track problem. TWS makes tracking information available in two forms: as a visual presentation to the operator, and as position and rate data inputs for use in computers, automatic displays, data links, and weapon control.

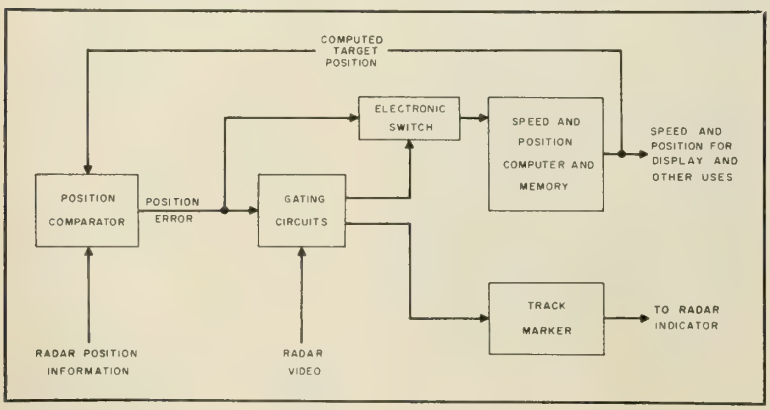
Each channel compares its computed target position with the actual scanned position on each sweep. When the computed position is determined to be where the actual target is by the TWS channel circuitry, it generates a video identification. This identifier is automatically imposed on the radar indicator screen at computed (and actual) target position.

• **Two operational modes**—Automatic tracking is performed by TWS in a Manual Entry mode and in an Automatic Detection mode.

In Manual Entry, tracking begins with target recognition by the operator and his decision to track it automatically.

The operator closes a switch and positions a video dot over the target. When the marker is superimposed over the target blip and a tracking channel is selected, initial target position data is then entered automatically into the TWS computing circuits and an electronic gate isolates the selected target.

The gate initially covers a 5-mile-square limit, but subsequently is reduced to a 1-mile square as TWS accuracy improves following each scan of the radar. As data are received, target position is measured and compared with an already computed position, generated from previously received inputs. Continual corrections with each scan further refine the position of the target and establish target rate corrections for speed determination.




*SIMPLIFIED BLOCK DIAGRAM of Servonics' new Track-While-Scan equipment.*

With Manual Entry, the radar operator monitors the operation and can at any time update tracking information or reposition the video marker. This may be necessary if lock-on is lost because of unusual noise-level, extended signal fading, or enemy radio jamming.

In the Automatic Detection (AD) mode, initial target detection and tracking channel assignment are performed automatically. As each target is detected, TWS assigns the next available channel to the blip after locating the electronic gate for target isolation.

A series of rectangular gates around the search area periphery are constructed by the TWS system when operating in the AD mode. By this means, a target is identified as it enters the scanning zone and is immediately located electronically.

When it is determined that a target—not just spurious noise—has been detected and lock-on and channel assignment are initiated, warning devices are activated to inform the radar operator. TWS operation is then identical with the Manual mode, providing automatic tracking and permitting manual correction when necessary.

• **Inherent limitations**—As indicated earlier, above-normal noise levels or deep signal fades can effectively break the lock-on of a tracking channel.

If, for example, reflected radar signals fade simultaneously with a change in target course, it might be impossible for the system to update the tracking channel in time. When the target reappeared, it could be at a position other than that computed by TWS from the last measured position and rate data.

The operator would have to reposition the video tag over the target

to reestablish the tracking operation.

Also, in the event of electronic countermeasures (jamming), radar information may in effect be reduced or non-existent. Tracking capability of TWS under these conditions similarly would be degenerated.

• **Repair/access simplified** — The compact modular design of individual channels permits easy access for maintenance. Each module, according to Servonics, is comprised of a number of circuit cards. These can be replaced readily if found defective by a series of sequential Go-No-Go lights.

Prototypes of the TWS system have been in test operation for several months in Servonics' Combat Information Center mockup in Alexandria, Va. The equipment has been used successfully with the company's AN/SPS-T2A Radar Target Simulator (M/R Nov. 30, 1959, p. 37) and an AN/SPS-6B Search Radar.

Both the Army and Navy reportedly have expressed interest in purchasing the system for military use. The Federal Aviation Agency also is considering use of such a system for civil aviation control. ⌗

## Sneak Blast Detector Set Up at Los Alamos

PROTOTYPE EQUIPMENT which may lead to an automatic worldwide system for detecting sneak nuclear detonations in near space has been put into operation at Los Alamos Scientific Laboratory.

The detection equipment was built for the Atomic Energy Commission by Edgerton, Germeshavsen & Grier as part of the *Vela* program.

The EG&G detector measures and records the fluorescence of atmospheric nitrogen caused by x-radiation from a nuclear explosion. The light from this fluorescence is picked up by special filtered lenses, amplified, and recorded photographically from oscilloscope traces.

## PGMIL Plans Special Microelectronics Issue

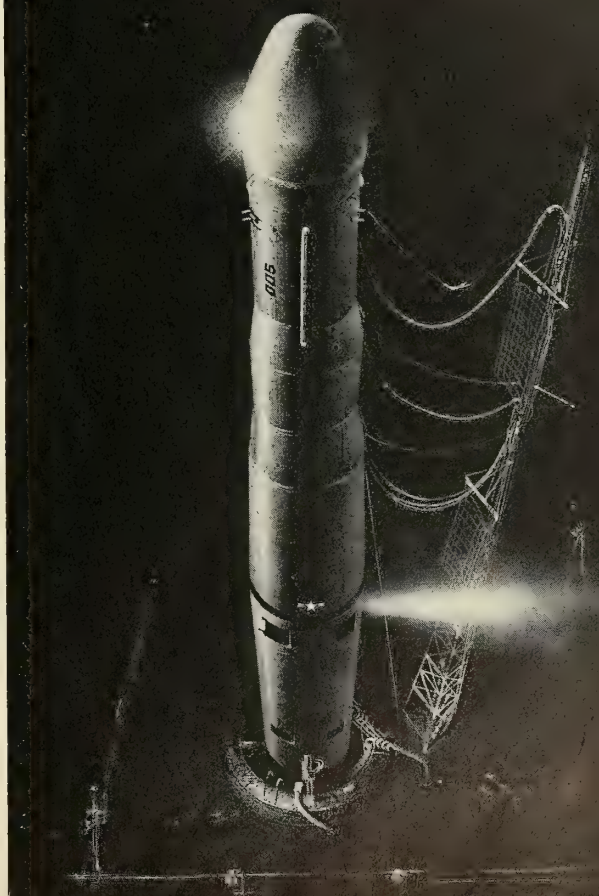
THE 10- TO 12-YEAR FUTURE of microelectronics will be covered by the entire July 1961 *Transactions* of the Institute of Radio Engineers Professional Group on Military Electronics.

Subjects to be discussed by papers in this special issue will range from basic research to production problems.

PGMIL members wishing to contribute should submit an abstract to guest editor J. E. Thomas Jr., Sylvania Electric Products, Woburn, Mass., by Feb. 8.


Space Electronics Corporation creates and constructs a wide variety of advanced electronic systems for the nation's missile and space programs. SEC is now responsible for fabricating the airborne and ground-based electronic systems for the USAF's most recent space booster. In its first flight relying on SEC electronic systems, it launched into successful orbit Courier 1B — the world's first active-repeater communications satellite. The booster:

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Qualified scientists and engineers are urged to direct their inquiries to the personal attention of Dr. James Fletcher, president.




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# MTC Solves Silicon Tubing Problem

***Development interests The Martin Co., Electric Boat as possibility for separation, photosynthesis***

**by John F. Judge**

LARGE-DIAMETER, extremely thin-walled silicone rubber tubing is in production at Materials Testing Co., Bethesda, Md.

The firm's manufacturing technique solves a problem that previously baffled the biggest companies in the business: how to extrude and cure such tubing without making it collapse, pinhole or stick together—and still maintain uniformity throughout its length.

Materials Testing is turning out tubing up to 3-in. inside diameter with a wall thickness of only 0.004 in. The material is permeable to oxygen—a desirable characteristic in certain life support systems for space.

Martin Co. researchers are already investigating the tubing as a membrane or separation device at their Space Medicine Dept., Denver. Scientists at Electric Boat Division of General Dynamics Corp. are also looking at the material for gas separation in connection with photosynthesis experiments.

The mechanism allowing the passage of oxygen through the walls of the tubing is complex and not completely understood, but it is being studied.

R. E. Mock, vice president, says that the difficulty of extruding thin-wall silicone rubber tubing is related to the inside diameter. As this diameter increases, the difficulty goes up almost logarithmically.

• **Strictly production**—Mock developed the extruding technique on standard production equipment. There was no laboratory incubation period in the process. Details of the method were not revealed, but formulation of the raw rubber material played a significant part. The problem, says Mock, was to come up with a compound of silicone rubber and ingredients that could be extruded and cured on production equipment. Current tubes are limited to lengths of 6 ft. or less because of the curing stages.

J. H. Duddy, General Manager, says that quality control and performance tests were run along with the development of the technique. In this manner, researchers at Materials Testing solved the many minor problems as they appeared.

The firm, under Dr. R. H. Peckham, has two functional divisions—Product Development and Testing. The Development section handles materials and applications research leading to the formulation of new natural and synthetic rubber products for a variety of applications. The Testing section has capabilities in environmental and performance tests, rubber technology, radiography and precision calibration. Most of the facilities meet the requirements of Mil-E-5272C.

With the advent of manned flights close to the fringes of space, the often catastrophic effects of ozone on natural rubbers and some synthetic elastomers is posing a major obstacle. The Testing section has a fully automatic ozone chamber and studies are constantly in progress to improve the physical and thermal properties of ozone-resistant elastromeric vulcanizates.

Tests involving high and low temperature, altitude, sand and dust, and marine environmental are also an integral part of the section. Duddy has plans for a space environment chamber which will include the combined effects of vacuum ($10^{-14}$ mm Hg), radiation and active chemical atmospheres. The chamber would be able to duplicate an entire flight regime. ⌗

## Liquidometer Measures Weightless Liquids

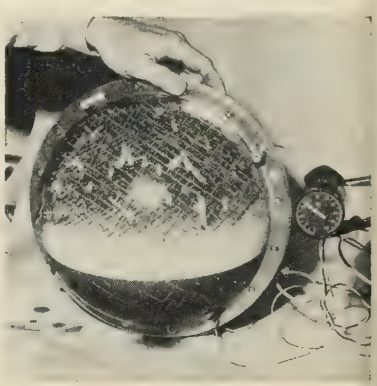
A TRICKY PROBLEM for spacecraft designers is *how* to measure the amount of liquid in a zero-g tank. The output might be feeding gaseous oxygen to an astronaut or metal vapors to an advanced propulsion system. In space, the tank's contents could ball up into a globule at the center of its container or foam into countless small bubbles.

One solution calls for a three-dimensional grid of capacitors in the tank. The grid senses the varied electrical field in the tank as a function of the total amount of liquid present. Then the grid's electrical signal is analoged into a pressure reading (See MISSILES & ROCKETS, Sept. 12, 1960, p. 36).

These first-release pictures show Liquidometer Corp.'s tank and capacitor-grid gage measuring a liquid phase (*left*), a foam phase (*center*), and a foam plus liquid phase (*right*). Note that the contents readings—given in percent of tank capacity—are the same. ⌗







# North American Aviation's

# Missile Division is now the Space & Information Systems Division

**This is the Division** that developed and is producing America's first successful air-launched strategic guided missile—SAC's GAM-77 Hound Dog—and brought it from drawing board to powered flight in just 21 months.

**This is the Division** that laid the foundation for a large part of America's current missile/space technology. Many of today's breakthroughs in aerodynamics, high speed flight, inertial guidance, large rocket boosters, materials, and manufacturing methods and equipment stem from original development work done by the Division.

**This is the Division** where the scientists of the Aero-Space Laboratories are seeking the keys to satellite rendezvous, refined trajectory analyses, space environment knowledge, lunar morphology, and materials to withstand space conditions.

**This is the Division** where intensive studies are underway on manned and unmanned space exploration vehicles, anti-ICBM projects, and information processing systems.

**This Division** is contributing vitally to America's rapidly developing space programs.

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# M/R EDITORIAL COVERAGE OF GUIDANCE



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# missiles and rockets

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**PUBLISHING DATE: FEBRUARY 27, 1961**

**CLOSING DATE: FEBRUARY 6, 1961**

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The current annual electronics market is estimated at $4 billion—guidance alone accounts for $1.5 billion. M/R is presenting a complete 40-page editorial round-up of military guidance systems, PLUS regular weekly features; news; developments. Major emphasis will be in these areas:

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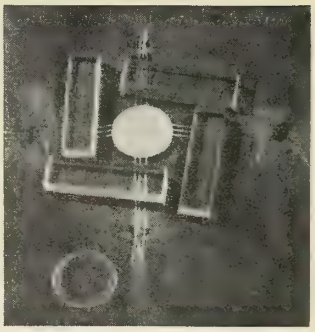
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# Radiometer to Improve Forecasting



**LEFT:** *Miniature radiometer needs only 50 microwatts in operation aboard NASA's Tiros II weather satellite.*

**RIGHT:** *Acrylic fiber grid supports radiation detector flake. Fibers also provide thermal insulation.*



IMPROVED RELIABILITY of future weather forecasts will result from measurements being taken by a 1.5 oz. instrument orbiting the earth in *Tiros II*.

The instrument, a radiometer, records the temperature of the earth and supplies data which permits comparison between the total solar energy received by the earth and the long wave thermal energy emitted by it.

This comparison is the earth's "heat balance" and its exerts a major influence on our weather.

Built by Barnes Engineering Co., Stamford, Conn., the radiometer owes much of its success to plastics. Except for its base plate, a few resistors, some platinum wire and the two radiation detector flakes, the instrument is all plastic. R. DeWaard, Chief, Applied Physics Section described the fabrication of the instrument.

• **Adhesive bonding**—The conical optical elements, which gather infrared and other radiation from the earth and condense it on the detector flakes, are formed Mylar. Besides its toughness and ease of fabricability, this material will not de-gas in the vacuum of space and high intensity random vibration does not damage it. Two of these cones are cemented to the aluminum base with a polyester adhesive. The base has a 3-mil layer of polyester to act as insulation.

The sides of the cones that face the earth in operation are vacuum coated with aluminum.

Each of the two radiometer channels has a tiny thermistor detector flake. Thinned liquid polyester is applied to the active sides of the flakes which then receive a coating of black or white paint, depending on the channel. The "heat balance" factor results from a comparison between the signals received from both the black and white channels.

The flakes are thermally insulated from the rest of the radiometer by mounting them on polyfilament acrylic fiber grids which have been previously cemented to the tops of the cones. The platinum leads from the flakes are tacked to the cone with the adhesive.

Gold is then vacuum-deposited on the back of the cones to minimize the transfer of radiant heat from the satellite.

Because resistance values must be precise, each resistor is brought to its exact value by unwinding some of the resistance wire. A new jacket is made from polyester and cemented over the adjusted windings.

After a multi-pronged connector is cemented to the base plate and a chrome-alumel thermocouple is attached, the channels are calibrated in an environmental chamber.

Remaining circuitry is completed and electronic components positioned. The top of each cone receives a thin layer of polyester and a final coating of gold. One last check for shorts and the radiometer is operational. ⌗

## *Superior Tubing Withstands Wind Tunnel Pressures*

STAINLESS STEEL in the shape of needle-size tubing, is handling internal pressures from 500 to 5000 psi without buckling in Mach 7-and-above wind tunnel operations.

Fabricated by Superior Tube Co. out of annealed temper type 304 stainless, the 16-gauge-diameter tubes are employed in pressure sensing apparatus.

Some of the tubes have been in operation as long as three years in a wind tunnel at Fluidyne Engineering Corp. without cracking or pinholing.

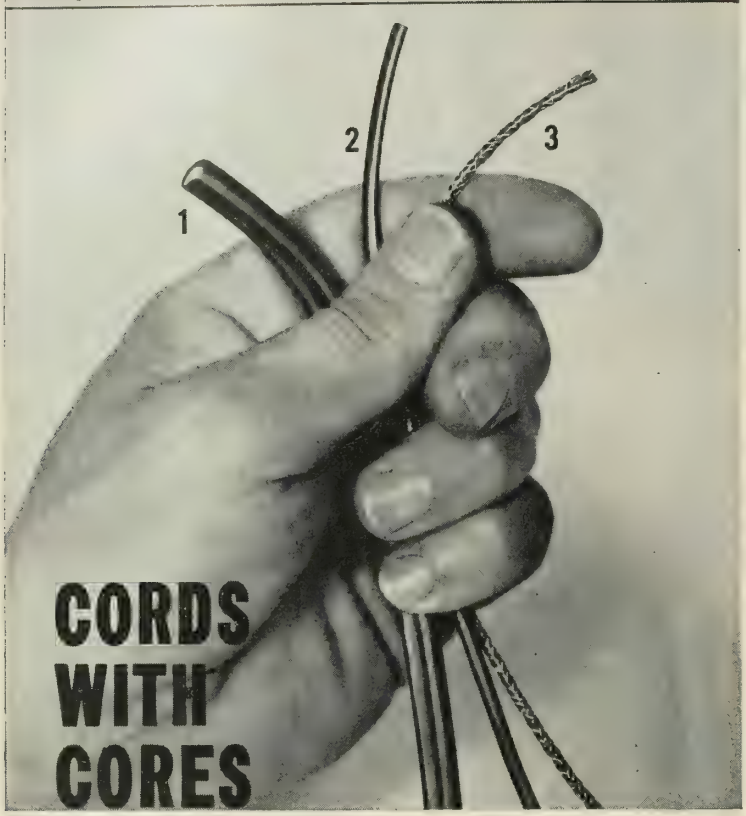
The ductility of the tubing is such that it can be freely hand-bent to complex shapes for application in tunnel model tests. Brass tubing failed within 20 minutes because of the corroding action of soldering flux.

The steel tubes are an integral part of Fluidyne's tests on models of rocket nozzles, inlet passages, external casings and missile configurations.



*HYPODERMIC NEEDLE-SIZED stainless tubes will be affixed to the model at as many points as there are pressure taps. Tubing inlets will sense pressure.*

*Ask your* **Du Pont Explosive Systems Specialist** *about:*




# that detonate or deflagrate

**Detonating Types**

**1. To cut, separate, rupture:** New FLSC (Flexible Linear Shaped Charge) applies explosive force directionally through V-Channel. The V-shaped flexible metal tube containing a high explosive core provides a sharply defined cutting action when detonated. This instantaneous cutting tool is useful in destruct systems, and for a variety of applications where rupture or separation is required.

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**A versatile ignition device:** Du Pont "Pyrocore," a flexible cord igniter, is a small diameter, continuous metal tubing containing a detonating-ignition core. Typical specifications are:

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Total Weight: Grams/Ft.—4-20
Approximate Velocity: Ft./Sec.—12,000-21,000

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## Joint Contracting Company Formed

FOUR COMPANIES have formed a new prime contracting source for missiles, rockets and weapons systems operating under a fresh management concept aimed at saving up to 15% on project costs.

The new firm, United Systems Corp., coordinates the missile/space specialties of CTL Division of Studebaker-Packard Corp.; Amcel Propulsion Inc., subsidiary of Celanese Corp.; Merz-Chambers Corp. and Technology Instrument Corp. of Acton.

E. P. Warnken, president of USC, says the cost reduction will be achieved "through elimination of pyramided general and administrative overhead costs, and anticipated reduction of profit at the prime contractor level."

Through its four stockholders, USC can provide systems service in all of its facets—research, design, development, engineering, manufacture, instrumentation, re-entry, telemetry etc. as a total project or any portion of a contract.

USC is a closed corporation formed with no intention of profit. Member firms will aim for profits at the subcontractor level. The corporate charter of USC is such that any stockholder can withdraw at will, but USC has a concurrent right to remove any member for adequate reason—such as allowing costs to get out of hand.

Provisions are included which allow for the substitution of another firm at the sub-contractor level if the particular project so demands. In this event, the stockholding firm excluded would not share in any profits under that specific contract but neither would it pay for accruing costs.

USC has two associate companies for consulting and "back-up" purposes. These are Technical Operations, Inc., Burlington, Mass. and Vidya Corp., division of Itek Corp., Palo Alto, Calif.

Proposals are already in preparation covering some sounding rockets and tactical assault weapons. These will be presented to NASA and the Army early in March.

In addition to Warnken, president of CTL, USC's executive committee includes J. P. Zeigler of Amcel, vice president and chairman of the committee, W. Williams of Merz-Chambers and L. C. Bower of TIC.

USC directors include the full executive committee plus J. H. Worth of Celanese, M. Sperling of Merz-Chambers, H. Cohen of TIC and G. Bruner of CTL. USC will be based either in Washington, D.C. or in the Mid-West under a general manager whose identity will be disclosed next month. ⌗


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## First Centaur Flights To Precede Tracking Net

THE FIRST THREE flights of the *Centaur* late this year will use existing tracking stations and thus may not achieve exact 24-hour orbits.

A joint statement by the National Aeronautics and Space Administration and the Department of Defense reported last week that a ground communication network specially designed for the circular equatorial 22,300-mile orbit will not be ready before the fourth *Centaur* launching, in the first quarter of calendar 1962.

When the new network is completed by DOD for the *Advent* communications satellite, *Centaur* will then use it instead of existing NASA facilities.

The azimuth of the three *Centaur* launchings with existing facilities will not be optimum azimuth for a 24-hour orbit. As a result, the chance of achieving a synchronous orbit will be marginal. The main objective will be to prove out *Centaur* as a launch vehicle.

The joint NASA-DOD statement summarized some of the actions taken by the Aeronautics and Astronautics Coordination Board since its establishment last September.

In another action, NASA and DOD representatives agreed that responsibility for development and procurement of each major launch vehicle will be taken by a single agency only. The Air Force has complete charge of procurement of *Agena B*, regardless of who uses the vehicle stage. NASA will have full responsibility for *Centaur* procurement.

The AACB, a twin-headed body is composed of equal representation from NASA and DOD at the management level. The board, headed by NASA Deputy Administrator Hugh L. Dryden and Director Herbert F. York of Defense Research and Engineering, took these other actions:

–Agreement that NASA should take on the job of issuing unclassified orbital information on satellites, following transfer to the North American Defense Command of the Air Force's Spacetrack facilities and the Navy's satellite detection net, SPASUR.

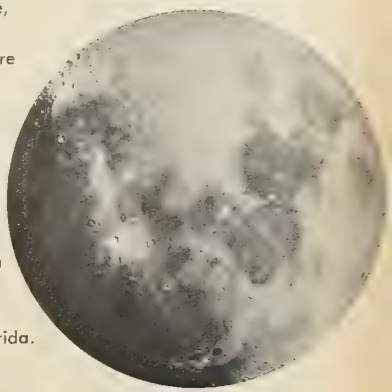
–Agreement on joint AF-NASA planning, funding and construction or modification of existing *Atlas* launch pads at Canaveral to provide pads for space vehicles using *Atlas* first stages.

The board has disbanded seven committees and liaison groups between DOD and NASA or its predecessor, NACA, and assigned four to panels of the board. It also assigned a new responsibility, the need to coordinate bioastronautic activities, to the board's Manned Space Flight panel, headed by NASA's Dr. Abe Silverstein. ⁂

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Guided Missiles Range Division of Pan American World Airways has prime responsibility for operation and maintenance of the 10,000-mile Atlantic Missile Range extending from Cape Canaveral into the Indian Ocean. Guided Missiles Range Division's dynamic growth has created new opportunities for Electronic Engineers, Systems Engineers and Physicists with degrees and experience in several fields. If you are qualified and desire to play an intimate, vital role in the nation's major missile test and astronautical explorations, we invite you to inquire about these career opportunities. You will discover that the Florida way of life offers you and your family modern living in an unparalleled vacation setting of sunshine and seashores; and that association with Guided Missiles Range Division offers beyond normal employee benefits, a 90% world-wide air-travel discount. Please address your resume in confidence to: Dr. Gilbert S. Blevins, Dept. B-36 Guided Missiles Range Division, Pan American World Airways, Inc., Patrick Air Force Base, Florida.



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GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA

by William Beller

# Sonobuoy Detection Poses Threat t

***Martin's FISH 2 proves feasibility of deep-ocean sonar for tracking subs—U.S. or Russian***

DEEP-OCEAN SONOBUOYS—new devices seemingly able to detect and track nuclear submarines—may soon raise strategic problems for U.S. and Soviet ASW planners.

A prototype of these future sonobuoys recently completed a year's successful check-out in the abyssal plains neighboring Bermuda. The device is now nearly ready to be coupled to a nuclear battery and subsequently arrayed with other sonobuoys into a tracking network.

If this system lives up to its promise, submarines of the *Polaris*-carrying type may soon lose some of their invulnerability, particularly offshore USSR and in the NATO waters.

At the same time, the Navy may have a system able to give very early warnings of enemy submarine action off the U.S. coastline.

• **The roof is one mile down**—The biggest problem that present-day sonar systems have in finding a submarine is brought in by the variableness of the ocean. The speed and direction of sound waves immediately below the water's surface—where most sonars are used—is about as capricious as the wind that blows above the water's surface.

Reason is that the sound vector is a function of water temperature, pressure and salinity. And these variables become increasingly difficult to predict the closer the air-water interface is approached.

Below 5000 feet, the ocean's physical variables are highly stable and remain the same all year long. The temperature changes only a few degrees with depth, and salinity is essentially constant. Thus, the velocity of sound is almost entirely dependent on pressure.

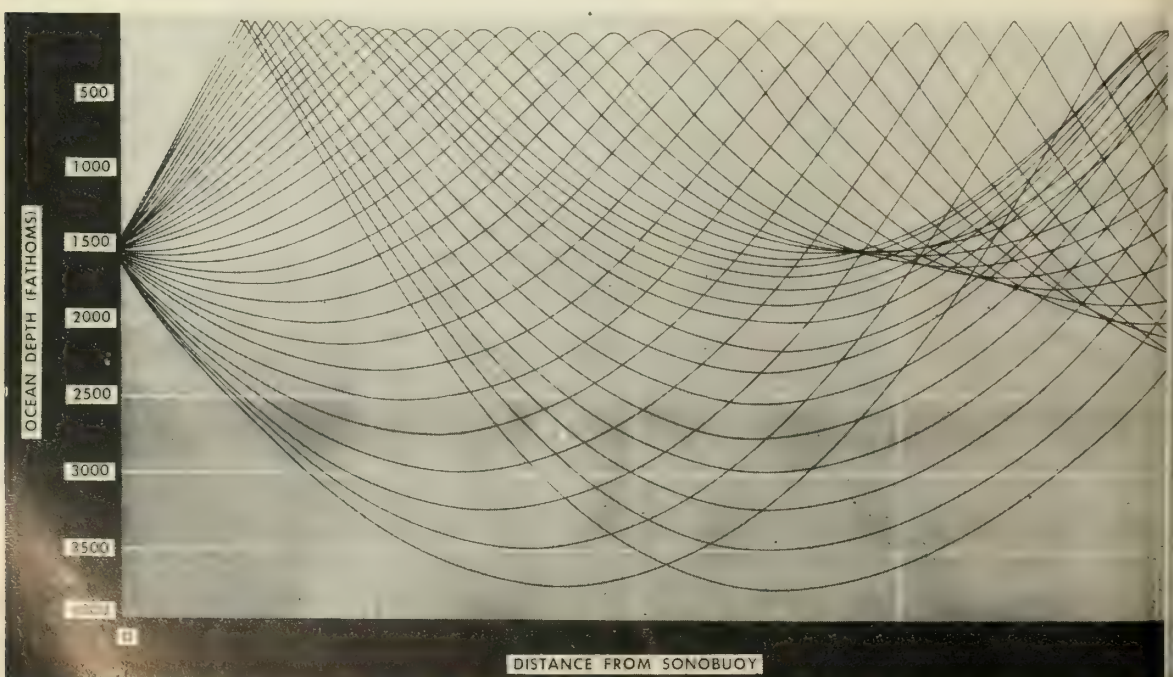
Two years ago, these facts led The Martin Company, Baltimore, to an obvious conclusion: put the sonar below 5000 feet where acoustic ray patterns would probably be stable and predictable.

Latest result of the Martin program is the present FISH 2, a deep-ocean active sonobuoy that for the past year has been tracing acoustic ray patterns down to 15,000 feet. Robert Bonner, the company's technical director of ASW, says that this work "proves the feasibility of deep-ocean sonar."

He points out that "We finally got rid of the problems brought about by the ocean's changing surface conditions. We replaced them by tremendous mechanical and electronic ones."

These include the design of equipment-housing able to stand up under 9000 psi (corresponding to 20,000-ft. depth), of an acoustic projector able to operate at that tremendous pressure, and of highly reliable electronics components.

The picture without nuclear battries shows the tough economic problem of getting submarine cable able to carry high power over long distances and at great depth. Present power needs of just one sonobuoy is estimated to be two to three kilowatts. Imagine the cost of the submarine cable for an array of such sonobuoys if it had to be fed by shore-based power sources!




*PATTERN OF ACOUSTIC RAYS emanating from "noise" source shows how, radar-like, it could detect an underwater object.*

# Nuclear Subs

• **Going FISHing**—Martin's FISH 1 is simply an acoustic projector with supporting cable and electronics. It was sent down to deep waters so that its power requirements could be learned and its acoustic patterns traced.

Its "noise" output came from pulsing the projector's housing, which was made of staves of barium titanate. This ceramic is a piezo-electric substance, and therefore can be made to vibrate under a power input.

FISH 1 performed so well that a hydrophone system—remotely steerable—was added to it and called "FISH 2." Tests over the past year have shown that from the angle and time interval of return of its acoustic signals, FISH 2 can locate a body in water.

An added dividend is that FISH 2 can be effective over a large water area because of the wide spread of its ray pattern.

Although Martin paid for the FISH work out of its own funds, the company had valuable technical inputs from Chester Buchanan, the Naval Research Laboratory's head of sonar systems; and material inputs from the Navy in terms of ship time and use of other facilities.

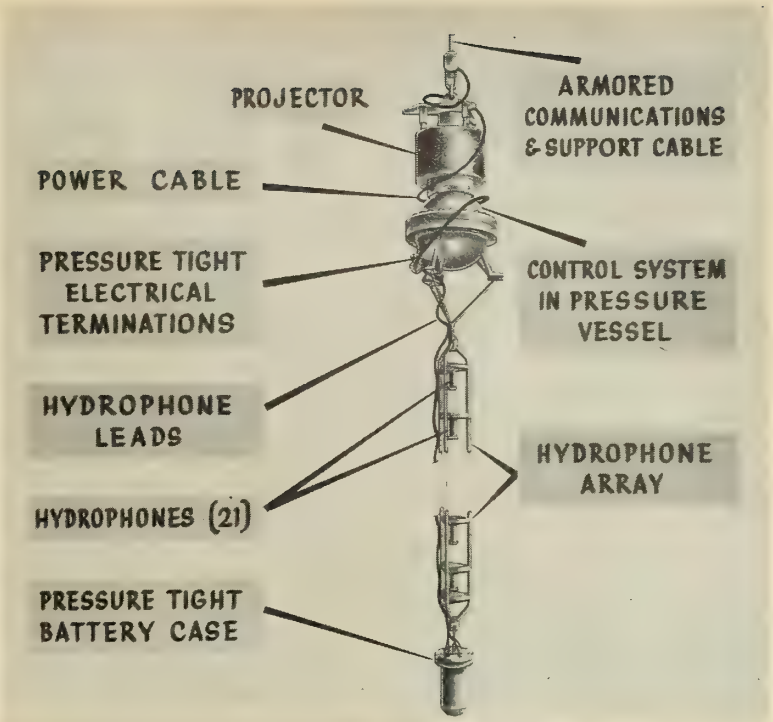
An array of deep-ocean sonobuoys suitably powered would permit enemy submarines to be tracked. This has not been possible in the past.

"If the enemy can make like a fish, then we'll have a real problem," says Bonner.

• **The strategic use**—A typical deep-ocean detecting and tracking active sonobuoy system would be powered by nuclear batteries. This is Martin's NUPAD (Nuclear Powered Active Detection) concept.

A sonobuoy and battery would last about ten years. It could include filters to screen out electronic countermeasures and other noise. Its output signals would run along fine wires about 0.1-in. diameter. These could be laid as fast as a ship can travel. They would ultimately feed a computer whose output would show tracking data for the ocean area under surveillance.

The USSR could use deep-ocean sonar to sensitize waters around England and Norway, the plying grounds of many missile-bearing U.S. submarines. The Soviet would not even have to run a land link to this system. The sonobuoy array could be interrogated by air, sea or undersea craft.

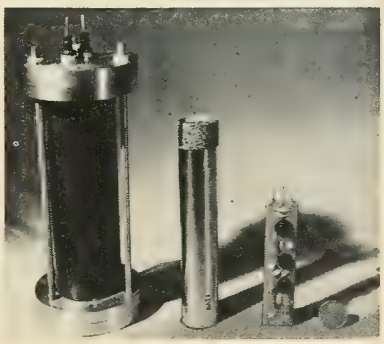


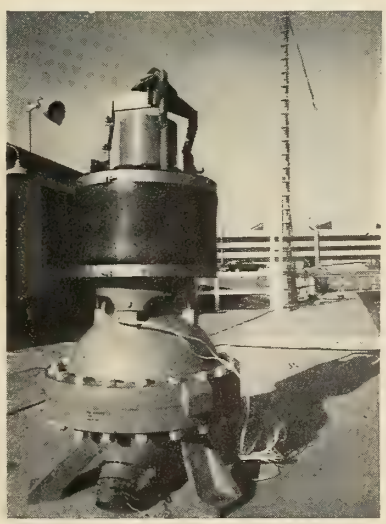

**ABOVE:** *FISH 2 (deep-ocean active sonobuoy) sends out signals at projector, gets vector return at hydrophone array.*

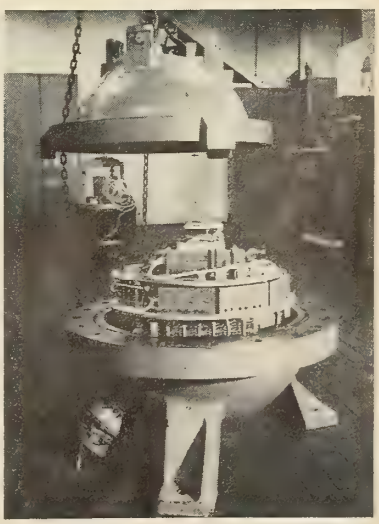
**RIGHT:** *Each hydroplane assembly includes a preamplifier (right), steel case (center), and hydrophone (left).*

**BELOW LEFT:** *Here is FISH 1, the projector plus sonar pressure sphere. Hydrophone array for FISH 2 is seen in background.*

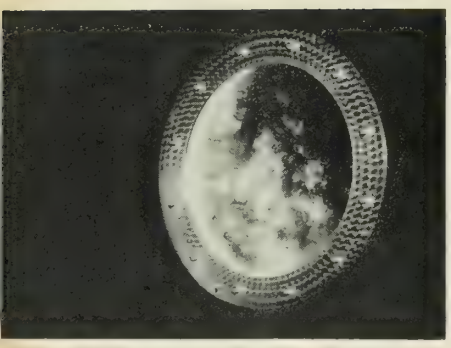
**BELOW RIGHT:** *Sonar pressure sphere opened up shows electronic equipment for controlling projector and hydrophones.*







# Space Viewports: Challenge to Glassmakers



**by Arthur F. Shoemaker**
*Corning Glass Works*

SPACE VEHICLE DESIGNERS are being forced to come to grips with the problems of viewports—problems given new urgency by the imminence of Project *Mercury, Dyna-Soar,* the B-70, space laboratories and other manned programs.

These problems are many.

A space vehicle viewport must, obviously, be strong enough so that it won't blow out—especially when the vehicle is manned. It must withstand operating temperatures, thermal shock and physical shock—the latter supplied by g forces, high aerodynamic loads in both directions, mechanical loads imposed by structural flexibilty, contraction and expansion, and—possibly —by encounters with micrometeorites.

In addition, the viewport must be transparent. It must perform adequately when subject to infrared and ultraviolet radiation, and incorporate special filters to protect the human eye, or to transmit selected wavelengths.

Viewports must also maintain adequate transparency and retain their mechanical strength properties in the presence of alpha, beta, gamma, X and cosmic radiation, if the vehicle is to spend much time in space.

• **Unknown quantity**—Of all things designed to fly in space, viewports are least tested, least proved. Virtually every other part of a space vehicle has been flown. But, to our knowledge, no man has been up in a true space vehicle, and hence the need for a window did not arise until comparatively recently.

The reason for viewports is simple enough: man must see in order to operate effectively. As long as a human is involved in a space mission, vision must be supplied, because of the obvious psychological factor, if for no other reason.

The overriding requirement for any viewport is that it must maintain the integrity of the vehicle enclosure, implying an order of reliability never before demanded. Such reliability is not cheap. However, costs can be kept down by involving materials manufacturers in pre-design stages as early as possible, by providing them with intelligence about the environmental conditions that are to be expected.

The peculiar conditions of space flight, including getting into and out of space, suggest glass as the one viewport material able to remain transparent under the environmental conditions that threaten the integrity of the enclosure. This is because a wide range of properties can be worked into glass. One type of glass may have a low thermal coefficient of expansion; another may have a high coefficient. The former can meet thermal shock and the latter can be strengthened to withstand greater physical shock.

Additional properties are surface hardness to minimize abrasion, high strain point to meet elevated operating temperatures, and ability not only to shield from dangerous radiation but also to remain clear under nuclear bombardment.

As a general rule, glasses with an expansion of 30 x $10^{-7}$/°C, or less, will have a modulus of rupture of about 8000 psi for short-time loading. Viewport panels made of such glass are designed primarily as thermal barriers. Mechanical forces due to pressure or structural stress concentrations will demand designs recognizing the strength limitations of the low-expansion glasses.

Conversely, higher expansion glasses —those with expansion greater than 30 x $10^{-7}$/°C—can be greatly strengthened to meet the mechanical stresses from pressure and structural loads. However, a discreet designer will choose a glass with as low expansion as possible that still can be strengthened, in order to get the most reliability from both mechanical and thermal conditions.

The number of panels in a viewport will depend on surface temperature of the outer panel, as well as the length of time it is exposed to heat. Heat will be transferred inward by convection and radiation, so a combination of between-panel spaces and infrared-reflecting coatings will be necessary to reduce heat input to the vehicle cabin.

• **Viewing angle important**—The viewing angle of the astronaut through the viewport also enters into consideration. If the angle is straight through, the number of panels could conceivably be limited only by their visible transmittance. That limit could be 15 to 20, with the consequent advantage of 14 to 19 between-panel spaces. But it is questionable whether such weight could be tolerated, even though the panels were very thin.

Once the level of transmittance is established, the viewport designer can count on loss of four percent per surface and ten percent per coating.

If the viewing angle is greater than 15 degrees off normal, then the number of panels should not exceed five. At this angle, reflections begin to increase to the point where transmittance falls off rapidly. Infrared coatings accelerate this condition, because they also are reflective in the visible range. Special non-reflecting coatings

could reduce the condition wherever IR coatings are not employed.

With a reasonable cabin cooling capacity, a designer could expect a five-panel configuration to withstand an outer surface temperature of about 1600°C. If the temperature should be higher, he probably will be forced to consider mechanical shielding. However, this is a function of exposure time.

Another factor to be reckoned with is polarization caused by reflection and double refraction. The problem arises from use of multiple panels and the birefringent characteristic of strengthened glass. The result is that the viewer may see a splotchy image if he is situated at approximately the polarizing (Brewster's) angle in relation to the viewport surface.

The ideal viewport shape, from the standpoint of the glazing material, is flat and circular. This is usually not the most desirable configuration areodynamically and visually, however. The viewport designer will probably be dealing with a different configuration for every vehicle likely to be launched.

There are presently three projects requiring viewports capable of withstanding space flight conditions: the *B-70, Project Mercury* and *Dyna-Soar.*

The *B-70,* a manned, controllable aerospace vehicle, will operate in a comparatively low temperature range, with temperatures on its viewport(s) much less than 1000°F.

*Mercury,* a rocket-launched orbital spacecraft returned to earth on a ballistic trajectory, will encounter outer panel temperature peaks of over 1000°F.

*Dyna-Soar,* also a rocket-launched orbital craft, yet controllable throughout its mission, will experience viewport temperatures in excess of 2000°F.

*Mercury* is the only one of these under which missions have flown or are close to being flown. Information from the *Mercury* missions will undoubtedly create experience bases for the other two programs.

In the original viewport design for the *Mercury* spacecraft, the outer panel was circular and curved to the outside capsule configuration. The other four panels also were circular, but flat. In the succeeding design, the shape and size of the viewport was changed because of a demand for maximum viewing area.

This viewport is a composite of four panels. The outer panel is a thermal barrier. It is made of 96% silica glass, which has a thermal coefficient of expansion of 8 x $10^{-7}$/°C. Approximately ⅜ in. thick, it has an aerodynamic curvature that matches the contour of the spacecraft. This panel is set in a floating attachment. Aerodynamic smoothness of the outer attachment is not absolutely necessary in this particular case because of the shape of the vehicle and the air flow around it.

The next inner panel, separated by an air gap, is flat. It also is made of 96% silica glass—about ⅛ in. thick. It also is a thermal barrier, and forms another air gap. Space on either side of this panel bleeds to the outside to eliminate pressure differential.

The two inner panels are flat, slightly less than ⅜ in. thick and also separated by air gaps. These panels are made of aluminosilicate glass, strengthened during manufacture. Both their attachments form pressure and water seals from inside and outside, meeting a double fail-safe requirement.

• **Panels pass rugged tests**—Panel strengths are qualified by "pre-testing" all production panels and testing some panels to destruction. The outer panel must withstand a pre-test load of eight psi and loads in destructive tests of more than three times this value. The next panel—the thinner 96% silica glass—must survive a pre-test load of two psi and destructive test loads of more than eight times this value. The aluminosilicate inner panels must withstand pre-test loads of 30 psi and loads five times this in destructive tests.

The strength of any glass is directly related to the conditions of its surface and edges. Therefore, extreme care must be maintained during any handling and assembly operations in order not to sacrifice the high degree of reliability that is possible. Stress concentrations must not be introduced by mounting. A polariscope helps indicate whether the mounting technique is correct.

• **Reflections eliminated**—The *Mercury* viewports presented the problem of multiple reflections that occur when a viewer looks through a number of transparent panels at an acute angle close to the polarizing, or Brewster's, angle. The problem arose from the fixed position of the astronaut in relation to the immovable position of the viewport, set in the capsule wall. The astronaut's viewing angle at the edge of the viewport nearest his eyes would be 44°. At the edge farthest from his eyes the angle would be 66°. Reflections created by this situation could not be ignored.

Theoretically, all images—real and reflected—would appear in one line if perfect parallelism between surfaces and between panels could be maintained. The first and most intense image would be the original, and all secondary images would appear next to it in a perfectly spaced series. However, it is impossible to achieve perfect parallelism. As a result, the many secondary images that occur with multiple panels are scattered and the real image becomes lost among them.



*SPECIAL, HEAT-RESISTANT glass, four panes thick, will go into viewports for NASA Mercury space capsule. The glass must not only provide picture window visibility but be able to withstand the heat and shock of re-entry.*

The problem of secondary images was improved by use of low-index magnesium fluoride coatings. Transmission at the most acute angle through the four panels was not less than 47%—a satisfactory level—and the coatings did not materially lower this level.

However, the astronaut's viewing angle is practically the same as Brewster's angle. The light composing his field of view would be polarized 90% in the vertical plane and 10% in the horizontal plane. A Polaroid film set for the vertical plane was introduced. It cut down the range of transmission at the most acute viewing angle to no less than 42%—still a satisfactory level.

The multiple images brought about by the 10% horizontal light were decreased to the point where they created no visible interference. ⁂

(Continued from page 13)

billion in the new budget are somewhat more than $1 billion.

• **Anti-missile work up**—The Navy received approval to obligate several hundred million dollars for tactical missiles. The procurement includes thousands of *Talos*, *Tartar* and *Sparrows*. The surface-to-air missiles will be used to equip the Navy's growing fleet of missile ships including seven guided missile frigates provided for in the budget. The Navy will also procure more *Zuni* air-to-air rockets and ASW *Asroc* missiles.

The Air Force received authority to obligate funds for air-to-air missiles for its tactical aircraft as well as air-to-surface *Bullpups* "above the 1961 level."

Under R&D, the Army, besides its work aimed at the first *Nike-Zeus* complete system tests in 1962, was authorized to continue obligation of funds for development of *Mauler*, a mobile missile capable of combatting both aircraft and tactical missiles.

## Astronautics

The U.S. space program—both military and civilian—continued to be the Eisenhower Administration's stepchild to the very end.

The budget authorized the Defense Department and NASA to obligate a total of $1.4 billion for astronautics R&D. That is less than $300 million more than the FY '61 budget provided.

NASA continued to receive the larger amount: $280 million. The military services received a total of $584 million with the Air Force receiving all but $80 million of if. Relatively modest additional funding also was provided to the Air Force for the *Dyna-Soar* spacecraft under the aircraft R&D account.

As in the field of missiles, the astronautics programs authorized were generally continued at their current levels of funding. Some programs such as *Dyna-Soar* and *Apollo* suffered cuts. Some were eliminated. There were no big new programs.

The military services were authorized to continue work of their satellite systems: *Samos* and *Midas*, the reconnaissance satellites; *Courier* and *Advent*, the communications satellites; *Transit*, the navigation satellite.

*Saturn*, the clustered 1.5 million pound thrust booster, received the biggest slice of the NASA research & development budget: $250 million.

Project *Mercury* received $74 million, a $35 million decrease that spokesmen said showed the program had reached the downward point in its spending. The new funding brought total cost of *Mercury* to $362 million, nearly twice its originally estimated cost.

• **NASA up $100 million**—NASA received a total spending budget including salaries and construction money of $965 million. That is $195 million increase over the current fiscal year including a new $49 million supplemental request. It is at least $300 million less than many in NASA sought.

The NASA budget carried $1.1 billion in new obligational authority. ⁂

## NASA R&D New Obligational Authority Requests

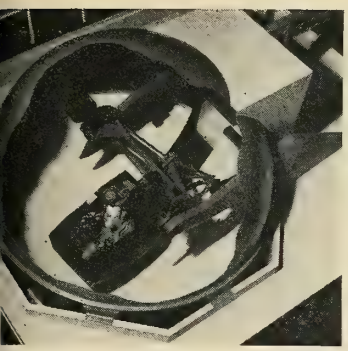
*(In Thousands)*

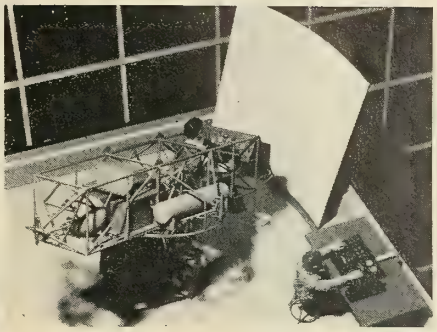
| | FY '61 | FY '61 Supplemental | FY '62 |
|---|---|---|---|
| Support of NASA plant | $48,203 | | $74,310 |
| Research grants and contracts | 5,000 | | 7,600 |
| Life sciences | 5,000 | | 8,620 |
| Sounding rockets | 8,170 | | 7,000 |
| Scientific satellites | 37,942 | | 64,700 |
| Lunar and planetary exploration | 77,524 | $ 5,000 | 103,899 |
| Meteorological satellites | 18,100 | | 28,200 |
| Communication satellites | 3,912 | 24,000 | 44,600 |
| Mercury | 109,525 | | 74,245 |
| Apollo | 1,000 | | 29,500 |
| Launch vehicle technology | 9,100 | | 15,000 |
| Launch operations development | 100 | | 9,500 |
| Spacecraft technology | 7,875 | | 10,360 |
| Solid propulsion | 1,300 | | 3,100 |
| Liquid propulsion | 57,000 | | 68,700 |
| Electric propulsion | 3,300 | | 6,800 |
| Nuclear systems technology | 10,000 | 2,600 | 24,000 |
| Space power technology | 4,200 | | 5,500 |
| Scout | 2,150 | 1,825 | 3,675 |
| Delta | 11,800 | | 2,900 |
| Centaur | 47,000 | 16,181 | 30,800 |
| Saturn | 118,058 | | 168,160 |
| Vega | | | |
| Tracking and data acquisition | 31,656 | | 38,650 |
| TOTAL | $617,915 | $49,606 | $829,819 |

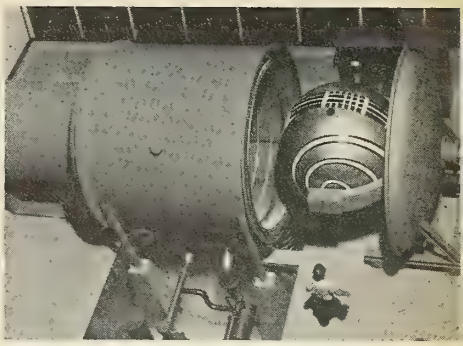
## OVERALL DEFENSE MONEY PICTURE

*(Millions of Dollars)*

| | New Obligational Authority | | | Direct Obligations | | | Expenditures | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY 1960 | FY 1961 | FY 1962 | FY 1960 | FY 1961 | FY 1962 | FY 1960 | FY 1961 | FY 1962 |
| Department of the Army | 9,970 | 10,130 | 10,530 | 9,867 | 10,379 | 10,594 | 9,392 | 9,615 | 10,073 |
| Department of the Navy | 11,369 | 12,460 | 12,237 | 11,727 | 12,579 | 12,802 | 11,642 | 11,765 | 12,078 |
| Department of the Air Force | 18,546 | 17,895 | 17,881 | 17,662 | 19,831 | 18,706 | 19,168 | 18,897 | 19,344 |
| Office of the Secretary of Defense | 1,173 | 1,189 | 1,341 | 969 | 1,262 | 1,321 | 1,013 | 1,223 | 1,415 |
| Sub-total | 41,058 | 41,674 | 41,990 | 40,225 | 44,051 | 43,423 | 41,215 | 41,500 | 42,910 |
| Available by transfer of prior year balances | −430 | −366 | −150 | | | | | | |
| Army | −281 | −260 | −125 | | | | | | |
| Navy | −99 | −76 | .... | | | | | | |
| Air Force | −50 | −30 | −25 | | | | | | |
| Total, Military Functions | 40,628 | 41,308 | 41,840 | 40,225 | 44,051 | 43,423 | 41,215 | 41,500 | 42,910 |
| Military Assistance | 1,331 | 1,800 | 1,800 | 1,605 | 1,896 | 1,875 | 1,609 | 1,700 | 1,750 |
| GRAND TOTAL, DOD-Military (Military Functions and Military Assistance) | 41,959 | 43,108 | 43,640 | 41,831 | 45,946 | 45,297 | 42,824 | 43,200 | 44,660 |







*SCALE MODELS of Chance Vought's proposed center show: 1) manned space flight simulator with vehicle mockup inside; 2) automatic controls evaluation simulator controlable by pilot or observer; 3) simulator to spin payloads.*

## Space Simulator Center Planned

A HUGE COMPLEX of simulators capable of testing both men and space vehicles will be put into operation in Dallas by Chance Vought Corporation within the next few months.

The three simulators, funded mostly by the company, will include a manned space flight simulator, a space environment simulator and an automatic controls evaluation simulator (ACES).

The manned simulator will move in three directions to duplicate space vehicle motions. Cabin environmental conditions of heat, noise and vibration will be duplicated, and a complete communications system will be installed.

Satellites, vehicles and systems will be tested in a space environment simulator capable of handling payloads of eight feet in diameter. The device will simulate altitudes up to 200 miles and temperatures down to –320°F. The company said it will be able to develop devices which will bombard test particles with meteoroid-like particles and possibly nuclear particles.

The environment simulator will be able to spin and rotate payloads to duplicate positions relative to the "sun," a device which will duplicate the sun's radiation spectrum. Chance Vought said the tests can be run for weeks at a time if desired.

The third simulator—ACES—will be used for research and development and test of automatic control systems for both manned and unmanned space vehicles. Floating on a near-frictionless cushion of air, the simulator will be used in testing and developing attitude control systems using reaction controls, inertia wheels, unique controllers and similar movement producing devices. The company's multimillion-dollar digital-analog computer complex will manage the system.

The three simulators will be used exclusively for Chance Vought space projects for an undisclosed initial period. After this time, the company announced, they will be avaliable to the government and to industry on a "time available" basis.

Chance Vought has roles in NASA's *Scout* and Air Force *Blue Scout* rockets, *Minuteman, Dyna-Soar* and other space programs.

## corporate changes

LING-TEMCO ELECTRONICS has moved to acquire a substantial interest in Chance Vought Corp. stock. Although no merger plans have been announced, informed sources report that Ling-Temco may own more than 10% and up to 30% of Chance Vought's common shares.

BELOCK INSTRUMENT CO. has opened a new facility for the machining of beryllium in Queens, New York City. The facility was designed by U.S. Hoffman Machinery Corp. in accordance with Atomic Energy Commission specifications.

FAIRCHILD CAMERA AND INSTRUMENT CORP. and Pacific Mercury Electronics, Inc. have agreed on the acquisition by Fairchild of certain assets and properties of Pacific Mercury in Joplin, Mo. Manufacturing equipment of the Graphic Equipment Division, Plainview, L.I., N.Y., are being transferred to the new plant.

CONSOLIDATED SYSTEMS CORP. has established a Photo-Optical Division to engineer, manufacture and market military cameras and precision instrumentation optics. CSC, located in Monrovia, Calif., is an associate company of Allis-Chalmers, Bell & Howell and Consolidated Electrodynamics.

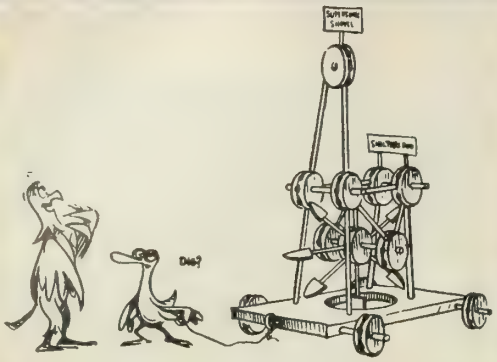
APPLIED MICROWAVE ELECTRONICS will construct a $100,000 modern office and laboratory building near Baltimore. The seven-month-old firm designs and manufactures precision microwave and electronic equipment components.

SPRAGUE ENGINEERING CORP. of Gardena, Calif., and Aeronautics Macchi of Milan have reached an agreement for close collaboration in the manufacture and sales of Sprague's support equipment and components in the European, Middle East and North African area.

LEAR, INC. has established an International Division to be headquartered in Santa Monica. Lear has sales and manufacturing agreements with firms in France, Great Britain, Sweden, Norway, Japan, Australia and India.

DYNATRONICS, INC., Orlando, Fla., will open a Pacific branch in Van Nuys, Calif., this month. Myron Roebuck, formerly VP in charge of special projects at Canoga Electronics Corp., will be VP of the Western operation. New branch will complement Florida activities and provide easier access and better communications with West Coast customers. Dynatronics manufactures range and airborne measurement and instrumentation equipment.

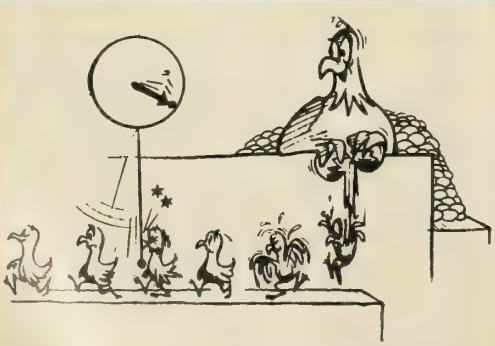
KIN TELL Division, Cohu Electronics, Inc., San Diego, Calif., has signed an agreement with F. Kanematsu & Co., Ltd. to be their exclusive sales representative in Japan. Kanematsu will handle the entire Kin Tell line and provide engineering field service for Kin Tell throughout Japan.



**UPTKIA*—2** *"It's a great idea, but I am afraid we don't have a crisis to justify it right now. But don't worry—there'll be one along soon!"*
*Useful Ploys To Keep Industry Alert



**UPTPIAI*—1** *"You've got a brilliant idea, Dr. Brown. We'll try to see that* you, *too, get an opportunity to bid on it."*
*Useful Ploys To Protect Industry Against Itself



**UPFEU*—7** *"For every new crisis, give birth to a new agency. It's a great way of keeping track of crises—just count your agencies. Turn crises-manship into agenciesmanship!"*
*Useful Ploys For Emergency Use

# books




**UPTPAC*—3** *"Pick the lowest bidder regardless—he may not understand the specifications but who knows something new and exciting may come out of it—some of the world's greatest men were born because of mis-takes."*
*Useful Ploys To Protect Against Capitalism

ANYONE AT ALL FAMILIAR with the Missile/Space Industry knows of course that its relationship with the Federal Government has been far from beer and skittles all the way.

But seldom before has anyone given a more amusing and simultaneously penetrating insight into that happy and patriotic partnership than have Messrs. Bernard Benson and Jack Roberts in their collection of cartoons called "Strictly Birdsmanship, or: How to Lay the Egg That kills the Golden Goose."

Both speak from long experience. Benson, the author and an ex-RAF pilot, is the founder and president of Benson-Lehner Corp. Roberts, the illustrator and an ex-USAF pilot, is a well-known Los Angeles advertising executive.

Benson-Lehner published "Strictly Birdsmanship" privately, but are making it available at $3 per copy up to 10 copies; $2.50 per copy for more than 10; more than 100—"will haggle."



**UPTKIA—6** *"But you don't seem to understand, Di Smith—the very fact that it took two years to negotiat the contract is the reason why you* must *complete th development in six months. You wouldn't want to b responsible for stifling progress, would you?"*

# contracts

## NASA

**Matrix Research and Development Corp.**, Nashua, N.H., for design and development of a varied multi-output power supply and a cosmic ray telescope assembly to be used in the *S-3* satellite. Two contracts, amount not disclosed.

**Matrix Research and Development Corp.**, Nashua, N.H., for a new high-voltage supply for use in satellites. Two contracts, amount not disclosed.

## NAVY

$750,000—**U.S. Chemical Milling Corp.**, El Segundo, Calif., for chemical milling, flotrusion and fiberglass fabrication and fabrication of *Sidewinder* motor cases. Subcontract from **Chance Vought, Convair** and **North American Aviation.**

$150,000—**Photronics Corp.**, Flushing, N.Y., for design and building of a periscope simulator for use in connection with the *Polaris* program. Subcontract from **Minneapolis-Honeywell Corp.**

## AIR FORCE

$8,000,000—**The Martin Co.**, Baltimore, for *TM-76B Mace* missiles, including inertial nose cone sections, production data, ground support equipment and spares.

$1,700,596—**Sprague Electric Co.**, North Adams, Mass., for capacitors for the *Minuteman*. Subcontract from **North American Aviation's Autonetics Div.**

$1,381,105—**Fairchild Semiconductor Corp.**, Mountain View, Calif., for transistors for *Minuteman*. Subcontract from **North American Aviation's Autonetics Div.**

$400,000—**Networks Electronic Corp.**, Van Nuys, Calif., for production of thermal relays for the *Falcon* air-to-air missile. Subcontract from **Hughes Aircraft Co.**

$200,000—**North American Aviation, Inc.**, Downey, Calif., for installation, check-put and test of *GAM-88* and S2-29A fluid distribution system.

## ARMY

**Olin Mathieson Chemical Corp.**, New York City, for design and development of a gas generator for the *Mauler* missile. Subcontract from **Convair Division of General Dynamics Corp.**

**Lockheed Aircraft Service**, Ontario, Calif., for testing and calibration of propellant loading systems at nine *Atlas* launch sites under construction near Cheyenne, Wyo.

$6,500,000—**Land-Air, Inc.**, for renewal of contract for engineering, R&D and instrumentation service at White Sands Missile Test Center.

$1,742,209—**The Martin Co.**, Orlando, for the production of six additional Birdie anti-aircraft defense systems.

$1,574,921—**George A. Rutherford Co.**, Albuquerque, for a discrimination radar building and facility at White Sands Missile Range in support of *Nike-Zeus* system.

$939,278—**Chrysler Corp.**, Detroit, for field service activities and depot maintenance service for the *Redstone* system.

$510,365—**Barnes Engineering Co.**, Stamford, Conn., for optical measurements for Project *Damp*.

$414,389—**Temco Electronics & Missiles Co.**, Dallas, for a "fast response progress reporting system" to keep construction of *Titan I* missile bases on schedule.

$325,000—**The Avco-Everett Research Laboratory**, Everett, Mass., for theoretical and experimental study of decoy discrimination for the *Nike-Zeus* antimissile missile system.

$302,059—**Sperry Rand Corp.**, Salt Lake City, for equipment training on *Sergeant* missile system.

$290,000—**Raytheon Co.**, Waltham, Mass., for replacement parts for *Hawk* guided missile system

$87,356—**Western Electric Co., Inc.**, New York City, for procurement of *Nike* spare parts. Two contracts.

$89,951—**Douglas Aircraft, Inc.**, Santa Monica, for supplies and services related to *Honest John* missiles.

$67,066—**RCA**, Moorestown, N.J., for down range measurement program (*Agena-Ranger* missions).

$48,834—**Raytheon Co.**, Waltham, for concurrent repair parts for the *Hawk* missile system.

$36,353—**Cornell Aeronautical Lab., Inc.**, Buffalo, for *Nike-Zeus* aerodynamic wind tunnel testing.

$35,308—**Permanent Filter Corp.**, Los Angeles, for *Nike* repair parts.

$31,189—**Tempo Instrument Inc.**, Hicksville, N.Y., for feasibility study of an electric timer for use in rocket and guided missile adaption kits.

$25,213—**Emerson Electric Mfg. Co.**, St. Louis, for *Honest John* fins.

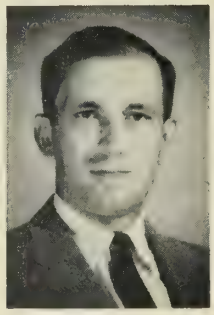



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# names in the news


ROBERTS


LORD


PHILLIPS


CALVERT


WISENBAKER

**H. P. Roberts:** Named general manager of The Siegler Corporation's Space Systems Technology Group, Inglewood, Calif. He was formerly manager of the test support department, systems engineering division of Space Technology Laboratories, where he directed testing of the *Atlas, Titan, Minuteman* and *Thor* ballistic missiles.

**Robert D. Calvert:** Appointed general manager of the Electro-Mechanical Division of Lear, Inc. Has been assistant general manager under former vice president and general manager **T. K. Greenlee.** Has also held management positions at Hughes Aircraft Corp. and General Electric.

**Glenn R. Lord:** Takes over the new position of vice president, government marketing for Raytheon Co.

Last previous post was vice president and general manager of the equipment division. Raytheon has also formed two new operating divisions, Aero/Weapons Division and Missile and Space Division. Aero/Weapons, which will continue the *Hawk* and *Sparrow* equipment program, will be managed by vice president **T. C. Wisenbaker.** The newly formed Missile and Space Division, responsible for new missiles and systems, will be headed by vice president **Thomas L. Phillips.** Vice president **Fritz A. Gross** has been promoted to general manager of Raytheon's Equipment Division.

**David S. Lewis:** Appointed executive vice president of McDonnell Aircraft. Other appointments: **Nicholas Dykstra,** to vice president-finance; Vice president **John F. Aldridge, Jr.,** given charge of advanced product planning; Vice president **Robert E. Hage,** in charge of the Customer Service Division and **Sanford N. McDonnell** as F4H vice president-general manager. **Chester V. Braun** will be *Quail* general manager.

**William W. Baker:** Becomes controller at North American Aviation's Space and Information Systems Division. **R. J. Armitage,** former manager of logistics field engineering and supply support, has been chosen director of logistics. **Kenneth B. Gay,** director of material for Atomics International division, takes over as director of material for the Space and Information Systems Division. **Earl D. Needham** has been named director of material for Atomics International.

**Dr. Frank B. Estabrook:** Given post of Chief of Physics Section at the California Institute of Technology Jet Propulsion Laboratory. A former research group supervisor, he will be in charge of basic research in physics.

**P. J. Fritch:** Chosen Rocketdyne controller, replacing **F. J. Knepper,** who has accepted the post of vice president-finance at the Autonetics division of North American Aviation. Fritch is former financial manager of Solid Propulsion Operations at McGregor.

**Dr. Richard B. Adler:** Named to the board of directors of Solid State Materials Corporation of East Natick, Mass. Is also Professor of Electrical Engineering at Massachusetts Institute of Technology.

**David Zopf:** Joined the Meteorology/-Oceanography Systems Engineering group of Borg-Warner Controls.

**Harry J. Johnson, Jr.:** Appointed sales engineer for Vitro Laboratories, West Orange, N.J. Will be Vitro's representative for electronic digital instrumentation systems.

**Boris Cohen:** Appointed division manager, Anti-Submarine Warfare Division for Loral Electronics Corporation. **Santo Scibilia,** former division manager of the Tactical Computers Division has been named division manager, Passive Detection Division.

**Charles R. Coleman:** Chosen for the newly established post of manager, administration-marketing, for the Electronics and Avionics Division of the Emerson Electric Mfg. Co. Comes to Emerson Electric from Hughes Aircraft Co.

**Joseph Toyzer:** Former plant manager for Radio Corp. of America facilities at Findlay, Ohio, and Indianapolis, named manager of manufacturing engineering for a new computer production center being completed by RCA at Palm Beach Gardens, Fla.

**L. G. Bliss:** Named chairman of the board of Foote Mineral Company. Will continue to serve as President of the company.

**Douglas D. Ordahl:** Selected manager of United Technology Corp.'s Propellant Development Branch. Prior to joining UTC, was associate head of the Propulsion Department at the U.S. Naval Ordnance Test Station at China Lake, Calif. Also served as head of the Internal Ballistics Branch, Propulsion Development Branch, Missile Components Division and Missile Propulsion Division during his 10 years at N.O.T.S.

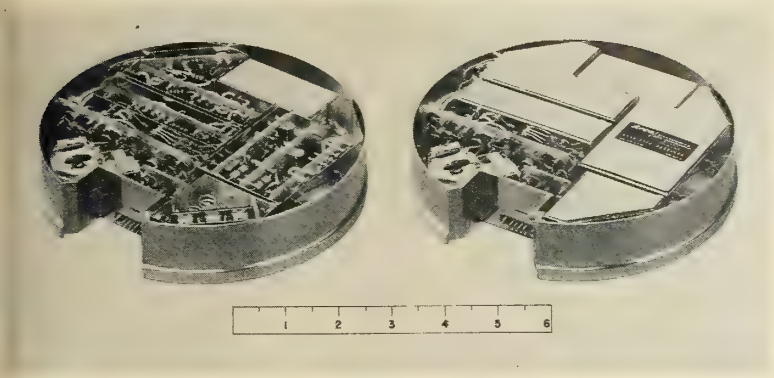
**Walter D. Smith:** Appointed chief engineer for The Martin Company's Cocoa division at Cape Canaveral. Formerly headed the missile field test department of Martin's Baltimore division, and more recently has been weapon systems manager for *Mace.*

**Robert F. Stewart:** Selected vice president of marketing of Gabriel Electronics, division of The Gabriel Company.

**Philip H. McLaughlin:** Named director of marketing for Vitro Chemical Co. responsible for marketing activities, sales, market research and market development. Previously served as general sales manager of Century Chemical Corp. and manager of sales development and technical services departments at Stauffer Chemical Co.

**Rainer Zuleeg:** Appointed senior staff physicist of Hughes Aircraft Co.'s semiconductor division. Prior to joining Hughes in 1959 Zuleeg was associated with the semiconductor research laboratory of Sprague Electric Co.

**R. M. MacIver:** Named manager of the Colorado Springs office of the Convair Div. of General Dynamics Corp., succeeding **R. W. Warden, Jr.** now assistant to the director of military relations.



## Lightweight Command Receiver

A lightweight command receiver for use in space satellites is available from the Electronics and Ordnance Division, Avco Corp.

Small and compact, the miniaturized receiver weighs only 1.5 lbs. Use of transistors and solid-state components helps account for the receiver's small size and weight, and also enhances reliability.

Designed to operate with the satellite receiver is a special decoder which also has been developed by the Division. A separate unit, the decoder is mounted with the receiver, and as the receiver accepts command signals from ground stations, it feeds them to the decoder to activate on-off control of the various electronic equipment in the satellite. Weighing only two lbs., the decoder accepts seven separate radio commands.

Circle No. 225 on Subscriber Service Card.

## Brazing Compound

A high temperature brazing compound capable of withstanding environments up to 1800°C is available from the Solid State Division of Electro-Optical Systems, Inc. The alloy is particularly suitable for joining porous, refractory metals, such as tungsten, molybdenum, or tantalum, to solid materials without infiltration of the permeable material. Low vapor pressure, low rate of diffusion, and cesium compatibility are characteristics of the braze material.

Circle No. 226 on Subscriber Service Card.

## Thimble Size Bellows

Metal Bellows Corp. has available a sensitive bellows for use in a force balance of closed-loop pressure transducers. The bellows design is about the size of a standard thimble. It provides high reliability for close dimensional control, accurate pressure response and long life.

Circle No. 227 on Subscriber Service Card.

## Differential Amplifier

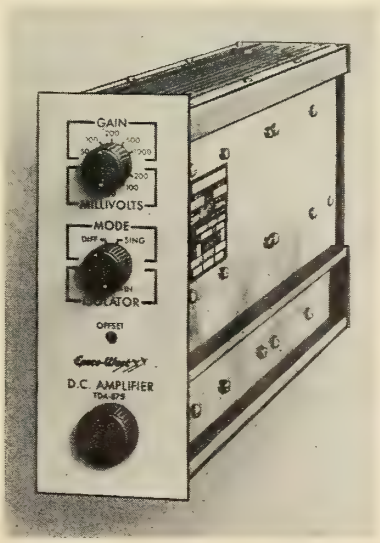
A transistorized differential amplifier is available from Epsco-West.

The Model TDA-875 was designed specifically for use in applications where high common mode rejection, high input impedence and solid state reliability are major considerations.

It has two modes of operation: differential and single-ended (Potentiometric). Selection is made by means of a front panel control. Five fixed gains are also chosen by a front panel switch.

The Model TDA-875 Amplifier may be used as a wide-band, floating, single ended, potentiometric amplifier by switching out the magnetic dc isolator. Amplifier gain is not affected by variations in load.

Circle No. 228 on Subscriber Service Card.




## Stand-off Insulators

Two Chemelec stand-off insulators have been added to the line of electronic components manufactured by Garlock Electronic Products.

The body of each of the new components is fabricated of Teflon. The turrets are machined from brass rod, with hot-tin dip finish to enable easy soldering.

Circle No. 229 on Subscriber Service Card.

## Differential Transformer

A series of differential transformer and variable reluctance pressure transducers, designed primarily for high temperature operation, are being marketed by Gulton Industries, Inc.

The differential transformer is Glennite PX series and has a nominal output of 40 mv/v input at 2000 cps. The PR series variable reluctance pressure transducer's nominal output is 15 mv/v input at 2000 cps.

Both are available with either of two diaphragms for each of the seven pressure ranges from 0-15 psig to 0-500 psig. A Ni Span C diaphragm, having excellent temperature characteristics, is suitable for most applications, while one of 17-7PH stainless steel is recommended for use in corrosive media.

Circle No. 230 on Subscriber Service Card.

## Lightweight Actuator

Chicago Pneumatic has available a P-156 Linear Actuator built to withstand salt spray and shock. The single phase actuator operates within a wide temperature envelope ranging from –65° to 160°F. Other environmental conditions include a humidity operating range from 0 to 95%. Designed to operate on an intermittent duty cycle, the P-156 is equipped with a thermal overload protector. An AC brake that limits coast revolutions and holds load under vibration, and a rotor slip clutch that absorbs rotor inertia at stroke termination into a solid stop are part of the unit.

Circle No. 231 on Subscriber Service Card.

## Hollow Shaft Clamp

A clamp designed for hollow shaft differentials is available from Empire Flight Components, Inc. and has been incorporated into their standard product line of precision miniature bevel gear differentials.

The design employs a V-block clamp, which is an integral part of the spider assembly. The clamp, located

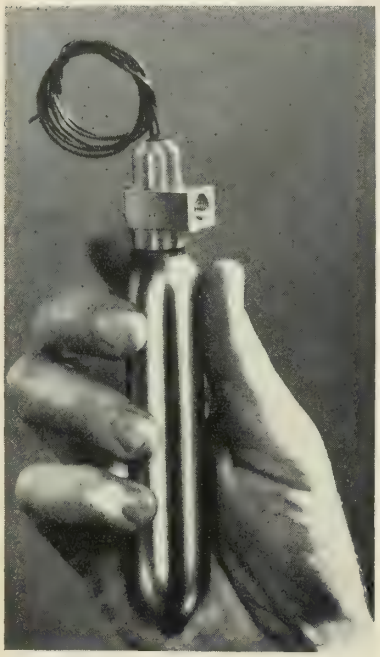
directly over the center of the hollow shaft differential, provides positive locking with the shaft when tightened down by 2 accessible screws. The V-block holds the shaft securely and will not mar or distort the shaft. The construction allows a considerable reduction in overall length of the assembly.

Circle No. 232 on Subscriber Service Card.

## Stored Energy Package

Con-O-Pak, a unitized fast acting stored energy package to actuate a wide range mechanisms, is available from Conax Corp.

This small, light weight, compact Conax Con-O-Pak releases high pressure gas from the storage bottle by an explosive actuated pressure release



valve which operates in only 0.002 of a second at recommended firing current of 2 amps.

The minimum firing current required to operate this explosive actuated valve is only the amperes from a power source as low as 1½ volts. Unique design permits Con-O-Pak to operate in explosive atmospheres with complete safety. Operating temperatures range from −65°F to −160°F.

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## Nuclear Gages

A line of nuclear gages for non-contacting thickness-density measurement and process control is available from Radionics, Inc.

The basic gaging unit, called a MICRO-METER, utilizes a highly specialized technique of scintillation detection developed by Radionics. The detector permits the use of either beta or gamma radiation, extending the range of application from the thinnest tissue paper to a foot of steel or more.

Sensitivities depend on the source selected. Gamma sources, with high penetrating power, allow measurements to within ± 0.001 in. of steel equivalent, while beta sources allow thin sheets and foils to be measured within a few microinches.

Circle No. 234 on Subscriber Service Card.

## Document Transmitter

High-speed facsimile scanning and printing units capable of scanning and transmitting page-width documents of any length at a rate of 15 linear feet per minute are available from A. B. Dick Co. Six hundred individual page-size documents may be transmitted and printed by the units in an hour.

The units can be operated back-to-back or remotely over wide-band transmission facilities. The scanner, with its vacuum-ported scanning drum, accepts random length documents for scanning and then transmits the intelligence in the form of video signals to its companion printer for either continuous or intermittent 'hard copy' print-out operation.

Circle No. 235 on Subscriber Service Card.

# new literature

GAS DRIVEN GYRO—Design and performance characteristics of two-degree-of-freedom gyro, driven by hot gas and designed to provide displacement reference for missiles during short-duration flights, are described in a brochure issued by the Instrument Division of Lear, Inc. The gyro features rugged construction, fast starts, an internally-stored propellant cartridge and low cost.

Circle No. 200 on Subscriber Service Card.

SYNCHROS—The Surplus Division of Servo-Tek Products Co. has published a 30-page Catalog No. 75. The catalog illustrates and describes synchros, AC and DC motors, servo motors, inverters, actuators, geared motors, generators, and other components of interest.

Circle No. 201 on Subscriber Service Card.

FLAME HARDENING—A 12-page brochure is available from Air Reduction Sales Co. on flame hardening equipment. Clearly illustrated and diagramed, the brochure discusses the various problems of oxyacetylene flame hardening and shows how these prolems can be solved with Airco equipment.

Circle No. 202 on Subscriber Service Card.

AIRBRASIVES—A bulletin, available from S.S. White Industrial Airbrasive Units, provides detailed information on improved cutting techniques, applications, performance charts, cutting powders, and accessories for the cutting tool. A section on cutting speeds outlines the factors which control removal of material—nozzle tip distance, Airbrasive flow, pressure, and type of abrasive powder. This section is complete with illustrative charts. A description of manual and automatic operation of Airbrasive is also included.

Circle No. 203 on Subscriber Service Card.

SOLAR CELLS—A 100 page handbook published by International Rectifier Corp. contains over 75 practical light-operated circuits, projects and demonstrations of both selenium photocells and silicon solar cells. Included are chapters on basic photovoltaic theory, nomenclature, radiation theory, photocell performance characteristics, power supplies, photometers, relays, photoelectric camera control, and infrared and ultra-violet photocell applications. Handbook is priced at $2.00.

Circle No. 204 on Subscriber Service Card.

ORGANIC CHLORINES—A 44-page booklet that describes the use or organic chlorine compounds as solvents, extractants, fumigants, intermediates, and special-purpose fluids, has been published by Union Carbide Chemicals Co. The booklet contains comprehensive data on 13 organic chlorine compounds. Included are physical properties, cleaning formulations; toxicological properties; shipping, storage and handling information; test methods, and selected literature references.

Circle No. 205 on Subscriber Service Card.

SERVOMOTORS—A catalog showing new models and up-dated specs on Size 8 and Size 11 Servomotors has just been published by Helipot Division of Beckman Instruments, Inc. Of special interest to systems engineers is a two page technical discussion of damping theory. This treatise compares and evaluates the various means to achieve damping, including rate-feedback and velocity-damping.

Circle No. 206 on Subscriber Service Card.

PLASTICS—A plastics catalog with technical information for machining, forming and processing plastics, such as Teflon, Kel-F, Nylon, Styrene, epoxies and Permali laminates, has been released by the R. S. Hughes Co., Inc. Specific information on dielectric insulation, tensile strengths, hardness, deformation, moisture and water resistance, linear expansion and contraction characteristics is given.

Circle No. 207 on Subscriber Service Card.

# when and where

## JANUARY

**29th Annual Meeting, Institute of the Aeronautical Sciences,** Hotel Astor, New York City, (**Honors Night Dinner,** Jan. 24) Jan. 23-25.

**1961 Plant Maintenance and Engineering Conference,** International Amphitheatre, Chicago, Jan. 23-26.

**American Mathematical Society, National Meeting,** Willard Hotel, Washington, D.C., Jan. 24-27.

**Society of Plastics Engineers, Annual Technical Meeting,** Shoreham and Sheraton Park Hotels, Washington, D.C., Jan. 24-27.

**American Institute of Electrical Engineers, Winter General Meeting,** New York City, Jan. 29-Feb. 3.

**American Society for Testing Materials, Committee Week,** Netherland Hilton Hotel, Cincinnati, Jan. 30-Feb. 2.

**American Physical Society,** New Yorker Hotel, New York City, Jan. 31-Feb. 4.

## FEBRUARY

**Institute of Radio Engineers, Prof. Group on Military Electronics,** Los Angeles, Feb. 1-3.

**American Rocket Society, Solid Propellant Rocket Conference,** The Hotel Utah, Salt Lake City, Feb. 1-3.

**Second Annual Symposium on Nondestructive Testing of Aircraft & Missile Components (unclassified), South Texas Section of SNT and Southwest Research Institute,** Gunter Hotel, San Antonio, Feb. 14-16.

**Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting,** Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, Feb. 26-Mar. 1.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

## MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.

**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

**American Congress on Surveying and Mapping, and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 5-10.

**Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by IRE, PGNS, AIEE, IAS,** University of Pennsylvania, Philadelphia, Mar. 9-10.

**American Rocket Society, Test Operations and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

**American Society of Mechanical Engineers, Aviation Conference,** Statler Hotel, Buffalo, N.Y., Mar. 13-17.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-17.


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### Advertisers' Index


American Machine & Foundry Co.-Government Products Group . . . . . 3
Agency—Cunningham & Walsh, Inc.

American Telephone & Telegraph Co. . . . . 6
Agency—N. W. Ayer & Son, Inc.

Arcturus Mfg. Co. . . . . 51
Agency—Anderson-McConnell Adv. Agency, Inc.

Avnet Electronics Corp. . . . . 9
Agency—Dale & Finkels, Inc.

Bendix Corp., The, Scintilla Div. . . . . 20
Agency—MacManus, John & Adams, Inc.

California General, Inc. . . . . 18
Agency—Barnes Chase Co.

E. I. Du Pont De Nemours & Co., Inc., (Explosives Div) . 36
Agency—The Rumrill Co., Inc.

General Materials Co. . . . . 19
Agency—Ritter, Sanford, Price & Chalek, Inc.

Government Products Group-American Machine & Foundry Co. . . . . 3
Agency—Cunningham & Walsh, Inc.

Kern Instruments, Inc. . . . . 8
Agency—Richmond Adv. Service, Inc.

Librascope Div., General Precision, Inc. . . . . 2
Agency—Compton Adv., Inc.

Minneapolis Honeywell Regulator Co. . . . . 17
Agency—Batten, Barton, Durstine & Osborn, Inc.

Pan American World Airways, Inc., Guided Missiles Range Div. . . . . 37
Agency—Willard E. Botts Adv., Inc.

Space Electronics Corp. . . . . 31
Agency—Gaynor & Ducas, Inc.

Space & Information Systems Div. of North American Aviation . . . . . 33
Agency—Batten, Barton, Durstine & Osborn, Inc.

Stearns-Roger Mfg. Co. . . . . 45
Agency—Mosher, Reimer, Williamson Adv. Agency, Inc.

Talley Industries . . . . 25, 26, 27, 28

United Aircraft-Norden (Ketay) Div. . . . . 4
Agency—Wilson, Haight & Welch, Inc., Adv.

Varian Assoc., Radiation Div. 52
Agency—Hoefer, Dieterich & Brown, Inc.

Vitro Engineering Co., a Div. of Vitro Corp. of America 10
Agency—Sam J. Gallay Adv.


EMPLOYMENT


Amcel Propulsion Inc., a Sub. of Celanese Corp. of America . . . . . 49

## editorial . . .

# For the Space Program—New Direction

THE NASA SPACE Budget contains few surprises. It has a Sleepy Hollow air of untroubled and unreal serenity.

The new Administration will probably, during Fiscal 1962, request more money than the carefully tailored $1,109-million complete package sought by the Eisenhower regime.

More important, however, is the attitude of the Kennedy Administration toward space exploration, and how the national space program is managed.

In naming Vice President Lyndon B. Johnson chairman of the Space Council, Kennedy has demonstrated that he wants strong central direction for a space program which will gain and hold world supremacy.

In this regard the space budget must be considered in the light of the report made by the President's Ad Hoc Committee on Space.

At least four members of the committee have significant positions. The chairman, Dr. Jerome B. Wiesner, is the President's Science Advisor and will be his chief consultant on space. Trevor Gardner resigned as Assistant Air Secretary for R&D in protest over former Defense Department policies. Officially or otherwise, his influence will be felt in the nation's space policies. Edwin H. Land, inventor of the Polaroid camera and board chairman of the Polaroid Corporation, has been almost exclusively engaged of late in work on the *Midas* reconnaissance satellite. Kenneth BeLieu is the effective and efficient director of the Senate Space Committee.

Among the recommendations made by the Ad Hoc Committee—recommendations which treated missiles as well as space exploration—by far the most important reads:

"Make the Space Council an effective agency for managing the national space program."

If this is done, and done quickly, then the remainder of the recommendations fall into line almost automatically. The undertaking—that of pulling together the scattered and loose ends of our present program—must cover at least four major areas:

–Management: firms quick, decisions and guidance for NASA, the Department of Defense and Congress.

–Civil-military: allocating programs and maintaining effective, harmonious relationships between the civilian and military teams in their work together.

–Projects: the exercise of infinite judgment and courage—the judgment to choose the most promising programs and the courage to abandon others.

–International: realizing that the United States cannot go it alone in its space program any more than it can be independent economically or militarily. International cooperation is essential.

OF ALMOST EQUAL importance is the field of industry-government space projects. The Ad Hoc Committee recommends machinery for such a program and, significantly, the NASA budget for Fiscal 1962 contains an item of $10 million in possible reimbursement for the launching of a satellite built and paid for by industry. This would mark the welcome entrance of private business into the space field.

The report of the Ad Hoc Committee represents the composite agreement of a diverse group of men who demonstrate a clear concern over the state of our space exploration program. It carries a tough incisiveness which has been lacking and which—we hope—may be communicated to the job at hand. Even if it means revising a budget here and there.

**Clarke Newlon**



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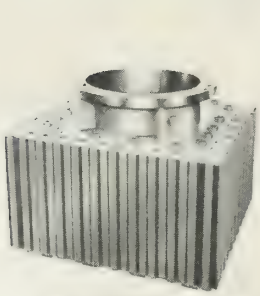
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VacIon 5000 Litres/second Pump

Varian's part in this? Varian's VacIon® pumps, up to 5,000 litres/second capacity, are used for the DCX experiment. Recently, a custom-designed VacIon pumping element with a much higher pumping speed was provided for installation inside the machine.

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JANUARY 30, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

JAN 1961
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## Kennedy's Big Decision

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*Zeus Gets 3rd Stage*

AN AMERICAN AVIATION PUBLICATION

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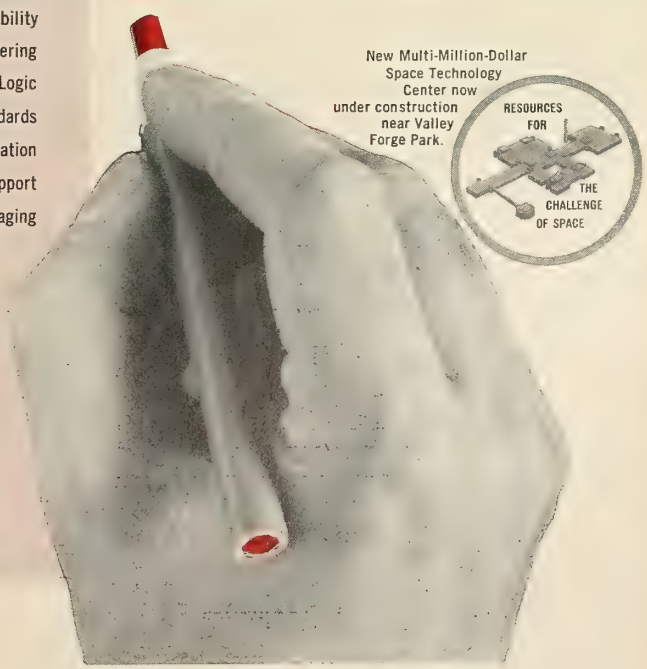
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- The **FIRST** recovery of an orbiting satellite vehicle. (Discoverer Satellite Recovery Capsule)
- The **FIRST** flight demonstration of effective space vehicle stabilization control and navigation.
- The **FIRST** measurements in space of earth's magnetic field and infrared radiation.
- The **FIRST** operational re-entry vehicles for both IRBM and ICBM missiles.
- **SUCCESSFUL** measurement of space radiation to an altitude of 1200 miles. ( NERV Space Probe)

## Look at Current Projects In Progress

- Re-entry vehicles for the TITAN, ATLAS, SKYBOLT & THOR missile programs. (Operational and Development Stage)
- NERV-Nuclear Emulsion Recovery Vehicle (Flight Test Stage)
- ADVENT Communications Satellite (Early Development Stage)
- Discoverer Satellite Recovery Capsule (Flight Test Stage)
- APOLLO Manned Space Vehicle (Also, five other Manned Space Vehicle Study Contracts)
- ADVANCED Studies in Space Probes









# "Delivery room" for a guidance system

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 5 January 30, 1961

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## THE COVER

*Technicians at Army's White Sands, N.M., facility attach third stage to the Nike-Zeus. A comprehensive report on the controversial antimissile missile starts on p. 26.*

## JANUARY 30 HEADLINES

First Polaris Sub Back from Successful Cruise ..... 62
General Dynamics, Lockheed Top FY '60 Contractors 62
Discoverer Communications Called Key to Successes .. 63
Tiros II Reduced to Infrared & Direct Observation .... 64
AT&T Authorized to Use Two Gigacycle Channels .... 65
Hughes to Build Surveyor Spacecraft for NASA ..... 65

## SPECIAL REPORT ON NIKE-ZEUS

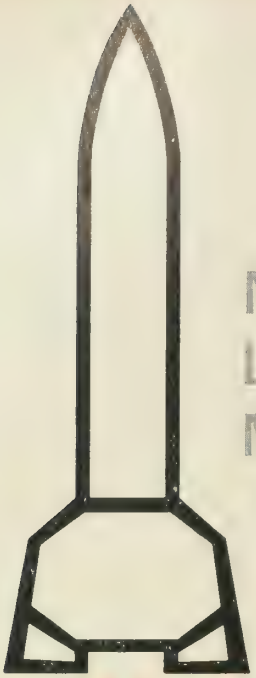
Kennedy Faces Decision on A-ICBM Production .... 26
The Formula: How to Kill an Oncoming Missile ..... 30
Host of Radar Difficulties Are Already Solved ..... 32
Missile Itself Poses Minor Production Problems .... 36
Special 'Skin' Protects Bird in Booster Flight ..... 42
'Sun Never Sets' on System's Testing Facilities ..... 44
How Two Components Makers Met Tough Requirements 46
Bases Will be Many and Land-consuming ..... 49
Army-Industry Management Team Ready to Roll .... 51
A List of Principal Contractors ..... 54

## DEPARTMENTS

The Countdown .... 11
The Missile/Space Week † ..... 14
Products & Processes . 55
Industry ..... 58
Names in the News .. 60
Contracts ..... 66
When and Where ... 67
Editorial ..... 70

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A battlefield might be anywhere. Wherever it is, there may be a need for the new 10,000-pound, 36-foot Sperry-Rand U.S. Army Sergeant missile. That's why the launching station on which the missile is assembled, aimed and fired must be light enough to be transported by land, sea or air. Yet it also has to be rugged and strong enough to assure the launcher's availability for subsequent firing.

N-A-XTRA steels meet all the conditions of light weight, high strength and impact resistance. Pound for pound, they're nearly three times stronger than mild carbon steel. They are used, not only in this mobile missile launcher, but in many other defense products and in commercial equipment such as earth-moving vehicles, heavy machinery and pressure vessels.

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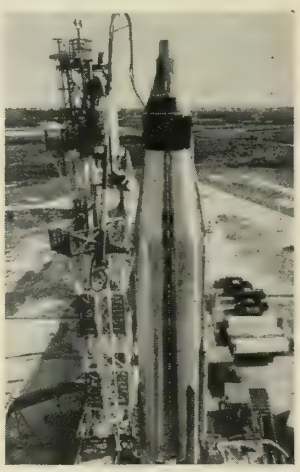
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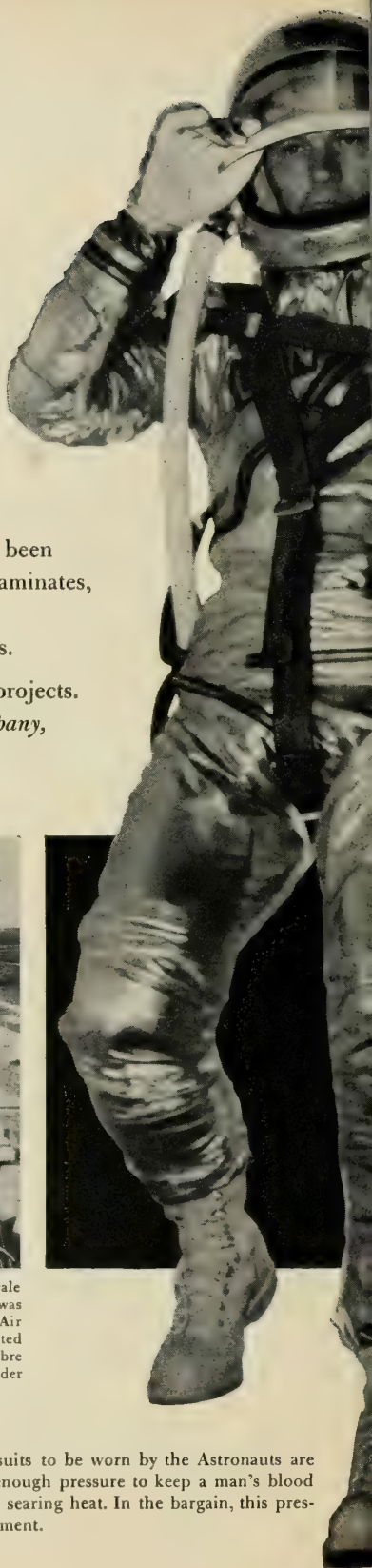
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Mock-up of Project Mercury capsule, built by McDonnell Aircraft Corporation for the manned orbital flight program of the National Aeronautics and Space Administration.

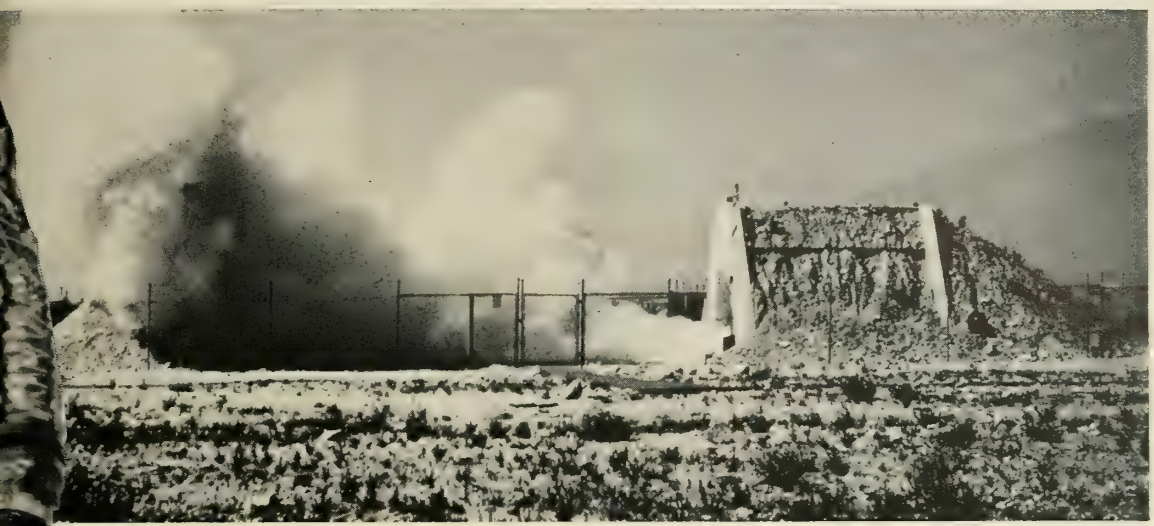


In "Big Joe" test launching, full scale model of Mercury space capsule was boosted 100 miles high atop this Air Force Atlas missile. Capsule was protected by a B. F. Goodrich laminated glass fibre and resin heat shield fabricated under subcontract to General Electric.



**SUITING UP THE ASTRONAUTS** The pressure suits to be worn by the Astronauts are now being fitted by B. F. Goodrich. This suit must maintain enough pressure to keep a man's blood from boiling, must provide air to breathe, must protect against searing heat. In the bargain, this pressure suit is light weight and flexible enough to allow free movement.

**HIGH ENERGY SOLID PROPELLANTS** This static test stand is one of 56 specialized facilities at the B.F.Goodrich solid propellant plant...currently processing and loading solid fueled motors of the LOKI, RTV and ASP types. BFG pioneered the development of the major polymeric binder-fuels now being used in the most advanced missiles.



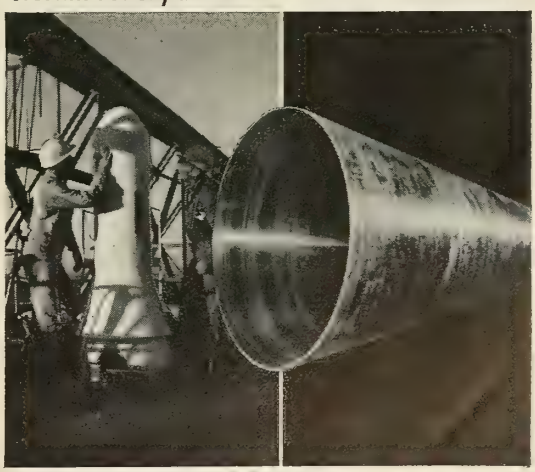
## B.F.GOODRICH ABLATION SHIELDS ARE USED ON THESE U.S. AIR FORCE/GENERAL ELECTRIC SPACE VEHICLES



RVX-2 Re-entry/Recovery Vehicle, the largest ablation-type re-entry vehicle to travel full ICBM-range and be recovered.



Satellite Aeromedical Re-entry/ Recovery Vehicle for USAF Discoverer Program.



Mark-3, an advanced operational-type re-entry vehicle for the Air Force Atlas.

# B.F.Goodrich aviation products

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Aerojet-General's AEROBEE/ASTROBEE series is a complete line of solid and liquid rocket powered vehicles for upper-atmosphere research. There is an AEROBEE or ASTROBEE for every test requirement, providing a realistic space environment for payloads up to 175 pounds at altitudes up to 3,000 miles.

Over 250 of these reliable vehicles have been launched since 1946—forty during the IGY alone. Typical missions include: studies of atmospheric composition; micrometeorite investigations; ionization, radiation, and magnetic field determinations; aeromedical experiments; high-altitude photography; re-entry problems; communications; and component testing.

Aerojet emphasizes the delivery of complete units ready for payload insertion, followed by overall program management. Included are engineering, field service, logistics, range operation, ground handling equipment, data reduction, and training of customer personnel.

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# The Countdown

## WASHINGTON

### Defense Dollars and the Congress

Chances of President Kennedy winning larger defense appropriations from Congress are looking up. Among key leaders with whom he is gaining support is Sen. Carl Hayden, the seldom-outspoken chairman of the Senate Appropriations Committee. Hayden has gone on record as saying flatly that "in the face of the continued Communist menace" Congress can expect to appropriate "much more" for defense.

### Titan II Enters the Space Race

Martin's *Titan II* is now a strong contender for the job of being one of the nation's major space boosters in the mid-60's. The Air Force this last week officially put *Titan II* in the space business by making it the booster for the *Dyna-Soar* program. The plan to use the less powerful *Titan I* has been dropped.

### Minuteman Moves to the Pad

After nearly a month of minor delays, the Air Force this week again hoped to launch its first R&D *Minuteman* from Cape Canaveral. The big solid-fueled ICBM was scheduled to be given a complete system test from a pad. The first launch of an R&D bird from the silo at the Cape is planned about early summer.

### Snag in Space Frontier?

Is there any significance in Kennedy's long delay in naming a new NASA administrator? Insiders are wondering if it presages a downgrading of the civilian space effort—or whether he just couldn't decide how he wanted to "redirect" it.

### Tiros: Paternity determined

A bubbling question in Washington for some time has been who is the "father" of the successful *Tiros* weather satellite. Some said NASA. Some said the Air Force. Some said the Navy. Some said . . . take your choice. Now the American Meteorological Society has made a determination. It presented its "special award" to Dr. Stanley M. Greenfield, an Air Force scientific adviser, and Dr. William W. Kellogg of Rand for providing 10 years ago the "framework which is basic" for the *Tiros* system.

## INDUSTRY

### Cheaper Bullpups

Martin-Orlando is driving for a 75% reduction in the cost of *Bullpups*. It says that in two years it has chopped cost per missile about 60%—bringing the present pricetag to the neighborhood of $4,000 per missile. Further reductions are expected from a new campaign to get vendors to drop their prices by 30%. Cuts to date were possible, Martin says, by eliminating all test equipment after bird leaves factory, making three main components (tail assembly, propulsion section and warhead) interchangeable so that Navy and Air Force can assemble them like rounds of ammunition.

### Seeker for Zeus?

Western Electric is "sold" on command guidance for *Nike-Zeus* (see special report starting page 26) but does not rule out possibility of shifting to seeker (probably IR) in following versions.

### Dyna-Soar Power Bidders

Finalists in the *Dyna-Soar* accessory power systems bidding are said to be Sundstrand Turbo, Walter Kidde & Co. and Thompson Products TRW team. Winner may be named about Feb. 14.

### R&D Intelligence

Navy will begin evaluating *Eagle* Air-to-air missile at Point Mugu about mid-year . . . Boeing, under an ARDC $100,000 contract, is filament-winding 3100-gal. rocket-fuel tanks with spun glass threads . . . For NASA, Douglas is studying use of earth orbits to launch lunar and interplanetary flights . . . Cal-Val is getting set to test a water injection system designed to reduce liftoff noise, vibration, heat and pressure. It could mean simplifying missile base design . . . $100,000 NASA contracts are putting Lockheed on a study of using *Thor*- and *Atlas*-launched *Agena* satellites for rendezvous and United Aircraft Labs on a study of mission data and launch dates for planetary orbits with ion propulsion vehicles.

### Hébert Back in Business

Rep. F. Edward Hébert and his House Armed Services Investigating Subcommittee are expected to resume inquiries into defense contracting in the near future. One of the top committee targets: Alleged overpricing in military procurement.

## INTERNATIONAL

### Swedes to Make Falcon

Licensing arrangement is reported almost complete for the manufacture of the U.S. *Falcon* air-to-air missile in Sweden. Agreement has been in the works since last April.

### Overseas Pipeline

Britain and Russia are sending electronics delegations to each other's countries, to tour factories and give lectures on current developments . . . France's government-controlled SEREB rocket agency has been allocated $20 million for development of an IRBM—said to have 2000-mile range and solid fuel.

### Chinese A-Test

Latest word from over the Bamboo Curtain has Red China getting ready to fire its first nuclear device from a 300-ft. tower in the desert of Sinkien province this year. Yield of the device is said to be 20 KT. It's reportedly made from Chinese-produced uranium.



# Western Electric manages the industrial team for Nike Zeus

Western Electric is proud of the responsibility assigned to it as leader of the Army's Nike Zeus industrial team of companies which brings together broad and diverse capabilities.

The selection of Western Electric as prime contractor was based on the qualifications and experience the Company has developed as manufacturing and supply unit of the Bell System. Western Electric and its partner, Bell Telephone Laboratories, work side-by-side as a team in providing the Bell System with communications products of the uncommon quality and reliability necessary to the operation of a completely integrated nation-wide communication service.

The reliability standards and the "sense of system" Western Electric employs in its telephone job are directly pertinent to the requirements of Nike Zeus. And it follows that Bell Laboratories accepts major development responsibilities in the Nike Zeus program, along with Western Electric.

In addition to their joint work for the Bell System, both Western Electric and Bell Telephone Laboratories bring major defense-project experience to Nike Zeus, from such missile programs as Nike Ajax, Nike Hercules, Terrier, and Titan. Other prime contracts in which the Bell System has played an important part include: DEW Line, White Alice, SAGE, communications aspects of BMEWS, and underwater sonar system projects. And in America's space exploration program, we are carrying heavy responsibilities in NASA projects: Mercury, Tiros, Echo, etc.

# Nike Zeus major industrial contributors headed by Western Electric, prime contractor:

| | |
|---|---|
| ALLIS-CHALMERS MFG. CO. | Target Track Antenna |
| ARMSTRONG CORK CO. | Acquisition Radar Dielectric |
| BURNS AND ROE, INC. | Technical Facilities Design |
| CONTINENTAL CAN CO., INC. | Target Track Antenna |
| CONTINENTAL ELECTRONICS MFG. CO. | Acquisition Radar Transmitter |
| DOUGLAS AIRCRAFT CO., INC. | Missile, Booster, Missile-handling & Test Equipment |
| DOW CHEMICAL CO. | Acquisition Radar Dielectric |
| GOODYEAR AIRCRAFT CORP. | Acquisition Radar Antenna |
| GRAND CENTRAL ROCKET CO. | Sustainer & Jet-head Motors |
| LEAR, INC. | Stable Platform |
| NARMCO MFG. CO. | Target Track Antenna |
| REMINGTON RAND UNIVAC | Computers |
| SPERRY GYROSCOPE | Target Track Radar Transmitter |
| STEEL PRODUCTS ENGINEERING | Missile Track Radar Antenna |
| STROMBERG-CARLSON CO. | Test Equipment |
| TEXAS INSTRUMENTS, INC. | Tactical Displays |
| THIOKOL CHEMICAL CORP. | Booster |
| VICKERS INC. | Target Track Antenna |

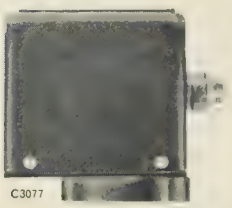
*In addition to these 18 companies, hundreds of other "partners"—many of them small businesses—are taking part in the research and development effort on the Nike Zeus anti-missile missile system.*

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Calco

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Standard and proprietary designs with field-proven reliability. Fast "off-the-shelf" delivery. Low cost, light weight actuator performs at up to 400° F. ambient.

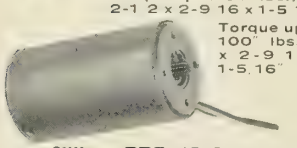
**Typical Specs**

**Voltages:**
115V. A.C.—400 C.P.S. single phase
26V.,115V.A.C.—2 phase
18 to 30V. D.C.

**Sweep:**
0°-360° or any increment

**Weight:**
Less than 3 4 lb.

**Envelope:**
Torque up to 30" lbs., 2-1 2 x 2-9 16 x 1-5 16"
Torque up to 100" lbs., 3 x 2-9 16 x 1-5 16"




**PRECISION MOTORS**

Size 12 frame motor matches performance of standard Size 15 under extreme conditions. 115V. A.C.—400 cycles per second, single and two phase. Certified at plus 425° F. ambient temperature. Nominal speed 10,500 R.P.M. Guaranteed minimum life 1000 hours. Weighs less than 8 oz. Brake and speed reducers available.

- Approved Air Force quality control system
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- Reliability program being adopted
- Complete design, manufacturing, assembly and testing

*Precision electro-mechanical components for airborne and ground support equipment. WRITE FOR INFORMATION*

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# The Missile/Space Week

## Shots of the Week

At White Sands Proving Ground, an Army *Hawk* scored a kill on the fastest target missile it has faced. The bagging of a *Corporal* brought to three the types of surface-to surface ballistic missiles *Hawk* has successfully intercepted.

At the Cape: The Air Force's *Atlas D* ended its testing career Jan. 23 by traveling 5000 miles down the Atlantic to bring its total to 35 successes, 8 partials and 6 failures in 49 launchings for the *D* model. The next day, the improved *Atlas E* developed engine trouble and sputtered out after completing only 100 miles of a 5000-mile test.

The Army's *Redstone* missile "satisfied all test objectives" on a 200-mile flight on Jan 23. However, the Air Force's 98-foot *Titan* tumbled into the Atlantic Jan. 20 when the second stage failed to ignite. The test, programed for 5000 miles, was an attempt to duplicate the success which marked the last firing of a liquid fueled missile in 1960.

## Nuclear Stage for Saturn?

Three engineers on Wernher von Braun's staff have proposed a nuclear third stage for *Saturn* which would generate 75,000 lbs. of thrust.

Willis Y. Jordan Jr., Donald R. Saxon and Paul G. Thomas of the Marshall Space Flight Center, National Aeronautics and Space Administration, last week told the Institute of Aeronautical Sciences that switching to a nuclear stage would double the *Saturn* payload.

The three-stage vehicle, standing 250 ft. tall, would consist of the *S-I* booster with 1½ million lbs. of thrust, the *S-II* second stage, generating 800,000 lbs. of thrust, and the nuclear stage. The *S-II*, a cluster of four Rocketdyne J-2 liquid hydrogen engines, is to go out to industry for R&D in about one year.

The vehicle would be capable of lifting a 30,000-lb. manned spacecraft and a chemical fourth stage into low earth orbit. The fourth stage would be fueled in orbit by *Saturn*-boosted tankers, and then could propel the craft to circumlunar and lunar landing missions.

*(Continued on page 61)*

## L-T Eyes Chance Vought

Ling-Temco Electronics has offered to buy 150,000 shares or more of Chance Vought Corp. stock at an above-market price in its move to gain control of the company.

Already possessors of "more than 10%" of Vought common stock, the electronics company offered to buy shares at $43.50 on a first-come, first-served basis. Chance Vought stock closed Friday on the New York Stock Exchange at about $39.875, but jumped several points by the middle of the week, hovering around $43.

The National Bank of Commerce, Dallas, will serve as escrow agent in the offer. The tender expires Feb. 1 but may be renewed, Ling-Temco announced.

There has not been any official disclosure of just how much Vought stock Ling-Temco now holds. Some estimates have reached 30-40% of the total shares, but Vought president Frederick O. Detweiler has stated that he believed it was "only on the order of 13% to 14%."

### —Coughlin New M/R Editor—

William J. Coughlin, Chief of the West Coast office of American Aviation Publications, has been named editor of MISSILES AND ROCKETS magazine. Coughlin is former head of the London and Moscow bureaus of the McGraw-Hill Publishing Co. and was chief of the San Francisco bureau of United Press. He is a veteran of 15 years of aviation and missile reporting.

Clarke Newlon, executive editor of the magazine, has resigned.

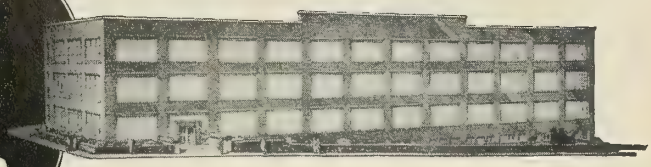
## Beryllium Breakthroughs?

The Air Force expects beryllium to break through current limitations in design and fabrication of heat-resistant structures for space vehicles. Maj. Gen. W. Austin Davis, commander of the Wright-Patterson Aeronautical Systems Center, said the metal also offers promise as a fuel additive because of its high energy content. The beryllium program is moving along faster than the

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### TYPE 2003



*Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles

Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)

Double triode and 5 pigtail parts required.

Input, Tube heater voltage and B voltage

Output, approx. 5V into 200,000 ohms

### TYPE 2007-6



TRANSISTORIZED, Silicon Type

*Size 1½" dia. x 3½" H. Wght. 7 ozs.*

Frequencies: 360 to 1000 cycles

Accuracies:
2007–6 (± .02% at —50° to + 85°C
R2007–6 (±.002% at +15° to + 35°C
W2007–6 (±.005% at —65° to + 85°C

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

### TYPE 2001-2



*Size 3¾" x 4½" x 6" H., Wght. 26 oz.*

Frequencies: 200 to 3000 cycles

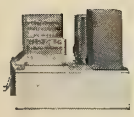
Accuracy: ±.001% at 20° to 30°C

Output: 5V. at 250,000 ohms

Input: Heater voltage, 6.3 - 12 - 28

B voltage, 100 to 300 V., at 5 to 10 ma.

### ACCESSORY UNITS FOR 2001-2



L—For low frequencies multi-vibrator type, 40-200 cy.

D—For low frequencies counter type, 40-200 cy.

H—For high freqs, up to 30 KC.

M—Power Amplifier, 2W output.

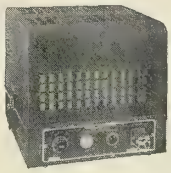
P—Power supply.

## PRECISION FREQUENCY STANDARDS

### TYPE 2005A

*Size 8" x 8" x 7¼" High*

*Weight, 14 lbs.*



Frequencies:
50 to 400 cycles (Specify)

Accuracy:
±.001% from 20° to 30°C

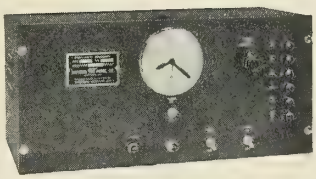
Output, 10 Watts at 115V

Input, 115V. (50 to 400 cy.)

### TYPE 2121A

*Size*
*8¾" x 19" panel*

*Weight, 25 lbs.*



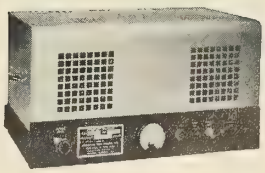
Output: 115V
60 cycles, 10 Watt

Accuracy:
±.001% 20° to 30°C

Input,
115V (50 to 400 cy.)

### TYPE 2111C

*Size, with cover*
*10" x 17" x 9" H.*
*Panel model*
*10" x 19" x 8¾" H.*
*Weight, 25 lbs.*



Frequencies: 50 to 1000 cy.

Accuracy:
(±.002% at 15° to 35°C)

Output: 115V, 75W.

Input: 115V, 50 to 75 cy.

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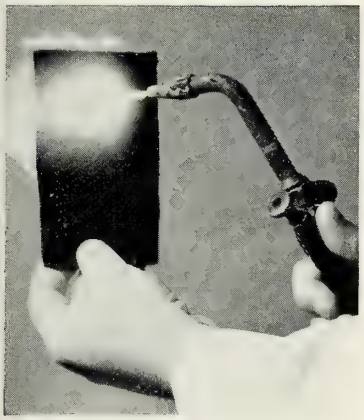
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LEAR



# 3M MATERIALS MEMO

News of materials for the aerospace industry — selected from the 27,000 products of the 3M Company



## Shades of Hades

Our market research people have never told us if there's a need for drapes over the gates of Hell. There may even be one or two of them on location there, but we've had no report so far. At any rate, our REFLECTIVE PRODUCTS DIVISION will be ready for the eventuality. They've developed a series of fabric constructions which are so heat resistant that they could easily "go to the Devil" and come back unharmed.

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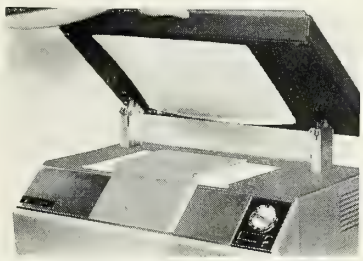
In addition to its "infernal" resistance, "Pluton" boasts several other eyebrow raisers. It's an excellent thermal insulator (K factor of 0.42 Btu/ft. 2/in./hr., compared with asbestos at 0.7). While "Pluton" is black in color, it contains no elemental carbon. This means it can act as an effective electrical insulator. Even after 10 minutes at 1300° F., resistivity is in excess of 100 megohms. Don't ignore its resistance to strong acids and bases. Boiling for 24 hours in 70% $H_2SO_4$, for example, fails to destroy it. So far, no solvent has been found which dissolves it, either.

Already it looks as if it can neatly step into any number of hot spots, either as a fabric or a resin-fabric composite. Perhaps yours is one of them. For more information, check the coupon at right.

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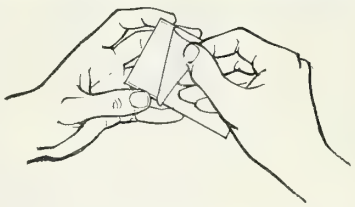
It seems almost axiomatic that the information we'd most like to preserve for our own files often comes to us in borrowed books or periodicals. Unless we're willing to risk mayhem or murder by snipping out the pages to copy them — we dutifully, but wistfully, pass the precious stuff along.

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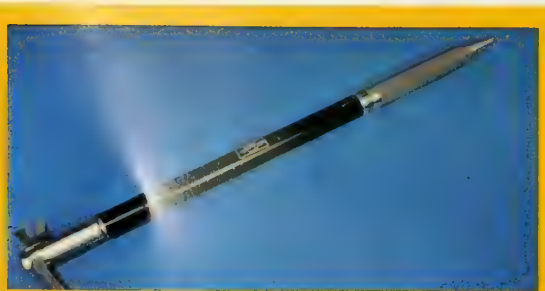
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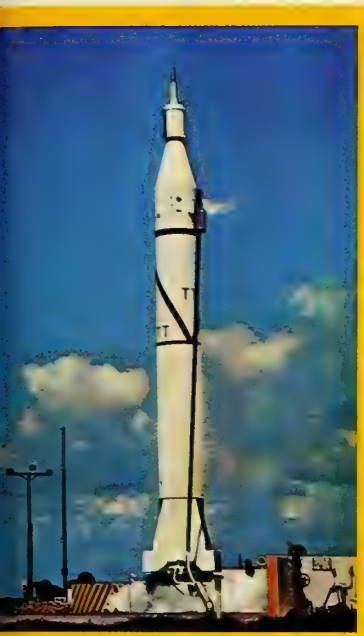
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**Missile wiring harness**—General Electric silicone rubber was chosen by Aerojet-General Corp. for the Titan's propulsion system wiring harness. Breakouts and junctions are molded from G-E RTV (room temperature vulcanizing) silicone rubber; wiring is silicone insulated; jacketing is high-strength G-E silicone rubber. Inset shows silicone rubber inserts in connectors. RTV is used in other missiles as a shock-absorbing encapsulant and potting material for electronic assemblies.



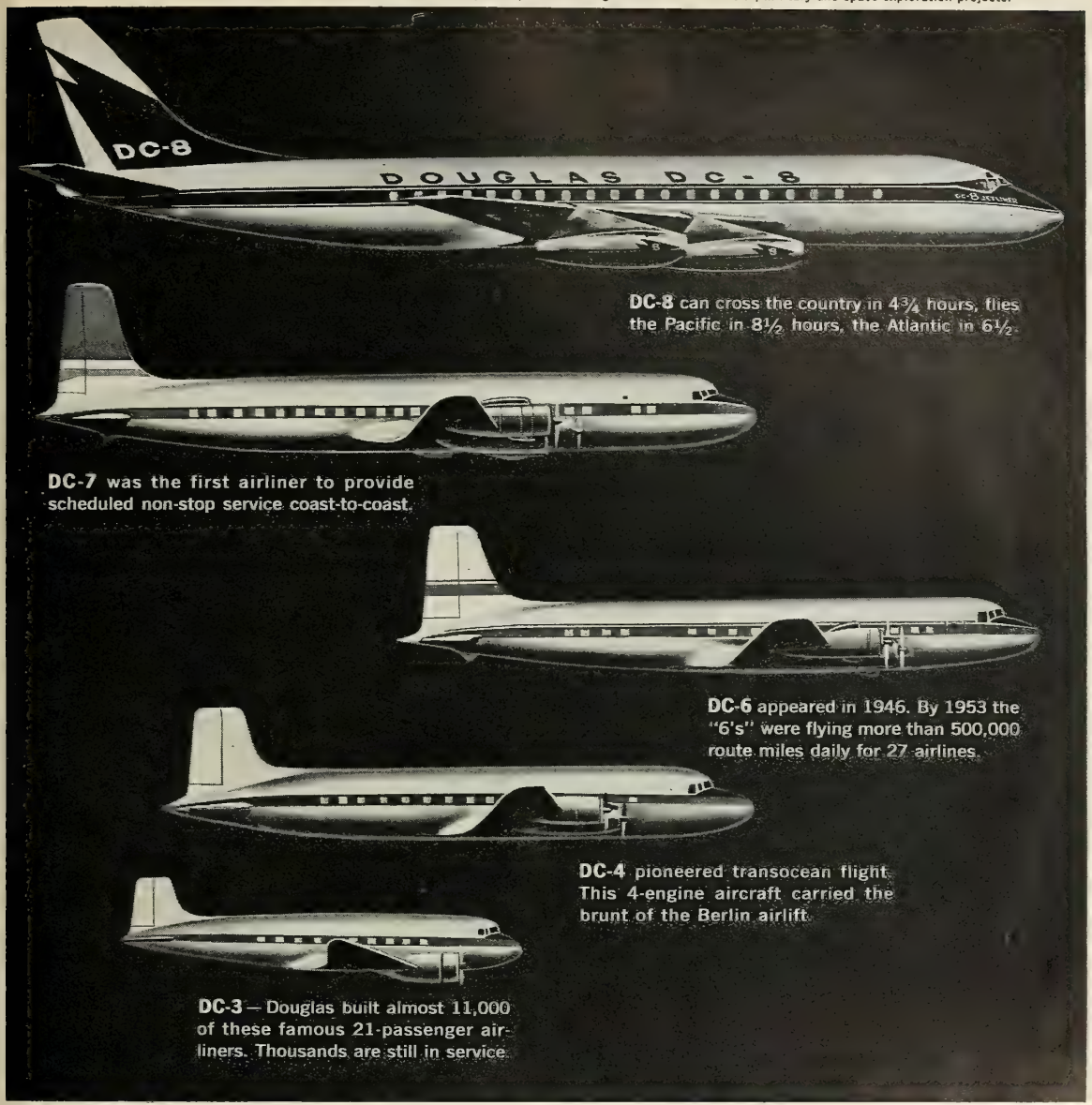
**200 tons of steel and concrete**—Titan missile silo doors by American Machine & Foundry Co. use seals of G-E silicone rubber. AMF also used G-E silicone rubber door seals on the Titan's ground support entry portals and radar silos. Silicone rubber can withstand the heat of rocket blast-off or possible atomic attack while remaining stable in storage for long periods.

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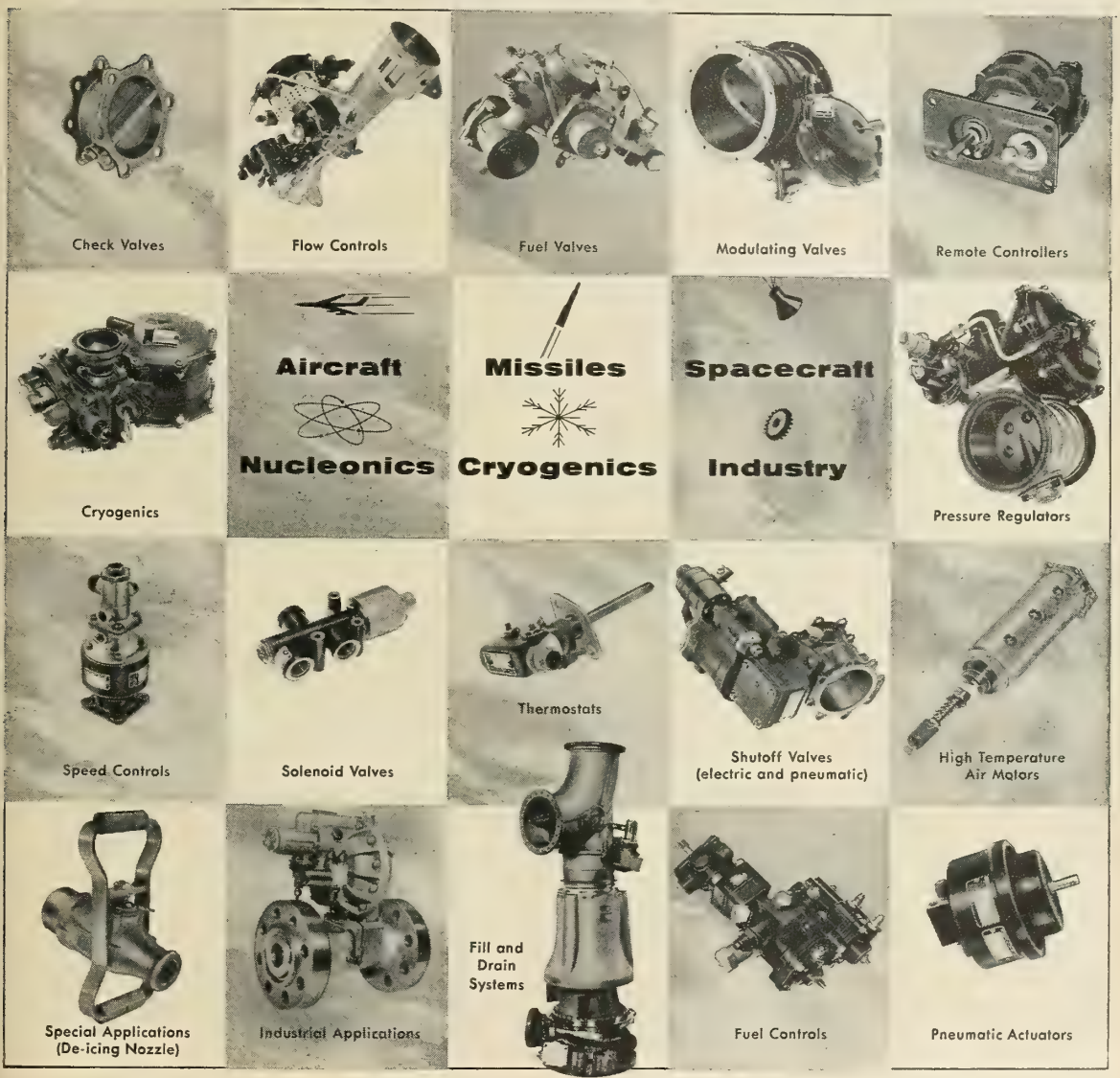
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*SPECIAL REPORT*

# NIKE-ZEUS NOW?



**by James Baar** One of the first critical military decisions demanding President Kennedy's immediate attention is whether to order the controversial *Nike-Zeus* antimissile missile into production. What makes the decision critical is time. *Nike-Zeus* is the only potential active defense against Soviet ICBM's available now, or expected to be available in this decade. Each day that a go-ahead order is delayed is a day lost in beginning deployment—which is three years away at the earliest. What will Kennedy do? Right now he has before him a last-minute recommendation by a top-level military-scientific group that *Zeus* be committed to production. This was left on the White House doorstep with a disapproving shrug by the Eisenhower Administration. But the pressures are great to push this recommendation into a pigeonhole. *(Cont'd next page)*

# $8 Billion Investment Gets Strong Backing . . .

If Kennedy acts this winter, the North American Defense Command can be expected to begin manning *Zeus* batteries in early 1964.

That would be more than a year later than would have been possible under the Army's original plan rejected by President Eisenhower.

It would be more than a year earlier than will be possible if Kennedy follows the Eisenhower plan to withhold production money until testing is completed in 1962.

The revised cost of producing and deploying a *Zeus* network to protect the nation's strategic forces and the majority of the U.S. population is estimated to be about $8 billion—a figure lowered considerably in the last year through technical advances in the *Zeus* system.

The inital cost is estimated at about $270 million for the first year.

• **Three-headed problem**—Essentially, there are three factors involved in the decision facing Kennedy:

–The first is technical. The Army and its technical experts have insisted since late 1959 that the *Zeus* system is technically assured and ready to go into production on a concurrent basis with the end of the R&D program. A number of experts outside the Army—including several in key positions have questioned this.

–The second factor is economic. The *Zeus* R&D program including obligations planned in the FY '62 budget proposed by Eisenhower already has cost more than $1 billion. Previous estimates of the cost of deploying *Zeus* have run as high as $13 billion to $15 billion.

–The third factor is strategic. Many military leaders outside the Army contend that the billions of dollars needed for *Zeus* would be better spent on increasing the size of the U.S. arsenal of strategic striking forces. Army leaders counter that without *Zeus* the Soviets are being offered a "free ride"; that *Zeus* would increase tremendously the number of ICBM's the Russians would need for a big war—thereby greatly augmenting U.S. deterrent strength.

All three factors were weighed during the closing months of the Eisenhower Administration by an Ad Hoc *Zeus* Committee set up by Richard S. Morse, director of Army Research and Development. The committee included key representatives of Defense R&E Director Herbert York and then Presidential Science Adviser George Kistiakowsky. Both York and Kistiakowsky have been leading opponents of committing *Zeus* to production.

• **Objections overruled**—The committee found that during the last year the *Zeus* R&D program has remained on schedule; both its time schedule and its dollar schedule. At the same time, many of the previously-questioned technical solutions to the problem of finding, tracking and destroying incoming ICBM warheads were proven to the committee's general satisfaction.

Moreover, two major theoretical arguments that have been used against *Zeus* were determined to have been generally vitiated.

One has been the question whether *Zeus* could discriminate between real warheads and decoys that looked and acted exactly like warheads.

The Army's answer is that after several years of study the only thing that anyone has been able to find that looks and acts exactly like a warhead is another warhead. As one Army official put it: "We can contend with any decoys that anyone in this country can prove to be feasible. We are as advanced as the threat—and more."

A second major theoretical argument that has been used against *Zeus* is the strong belief among a number of scientists that there must be a cheaper and more effective method. For example, destroying an ICBM during its launch phase or intercepting it with a ray or a cloud of particles.

The Army's answer is that ARPA has spent some $300 million on Project *Defender* during the last two years and so far has found no feasible alternate to *Zeus*.

Lt. Gen. Arthur Trudeau, chief of Army R&D and a leading advocate of *Zeus*, recently commented bluntly:

"We must face that if we want a missile defense system in this decade *Zeus* is the only answer known to the Free World. I would like to be able to hit enemy ICBM's on the launching pad. I'd like to hit them as they come out of the factory door. But today *Zeus* is the only practical system."

In the field of military strategy, the committee particularly considered increasing military demands for an active antimissile defense. One of the principal leaders in making these is Air Force Gen. Laurence S. Kuter, commander of NORAD.

Finally, the committee read recent intelligence reports that the Soviets have an antimissile missile under development.

• **Recommendation unavailing**—In the end, the committee recommended to Morse that the Army should immediately begin production of *Nike-Zeus* on an "interim" basis. The report was passed on to the Office of the Secretary of Defense, but no change in policy resulted.

The final Eisenhower budget called only for obligating about $250 million more in FY '62 for *Zeus* to complete the test program. There was no money for production. Moreover, Eisenhower stated flatly in his budget message:

"Funds should not be committed to production until development tests are satisfactorily completed."

The "interim" production program proposed by the committee is based on the minimum number of batteries that it would be feasible to manufacture.

The cost the first year would be about $270 million. The cost the second would be about twice as much.

Such a program would offer two considerable advantages: It could be expanded after the first year to the full program sought by NORAD without any loss of time. It could be greatly expanded after two years with only some loss of time. Deployment of the first batteries still would be possible in 1964.

Essentially, the committee's recommendation is saying that the saving of nearly two years in time is worth the investment of about three quarters of a billion dollars.

"If you never went beyond the interim program at all, *Zeus* would be highly useful," one Army official argued recently. "At the very least you would have some means of taking care of mistakes.

"The odds are that sooner or later one of these ICBM's is going to get loose and then what do you do? Even a limited number of *Zeus* batteries would solve the problem."

• **The big question**—But such considerations are merely side issues. The central issue before Kennedy is whether

## Army programed spending on Nike-Zeus

*(in millions)*

| | | |
|---|---|---|
| FY '57 and previous | $12.2 | (R&D) |
| FY '58 | 55 | (R&D) |
| FY '59 | 210.6 | (R&D) |
| FY '60 | 297.8 | (R&D) |
| FY '61 | 302 | (R&D) |
| | 22 | (Pre-production |
| FY '62 | about 250 | (R&D) |

*(Nearly half of all money going into the Army Guided Missile Agency is for Zeus. About one quarter of all money going into the overall Army Ordnance Missile Command is applied to Zeus.)*

# NIKE-ZEUS

## Tough Rad

***R&D work of more t breakthroughs and for mass production***

**by Charle**

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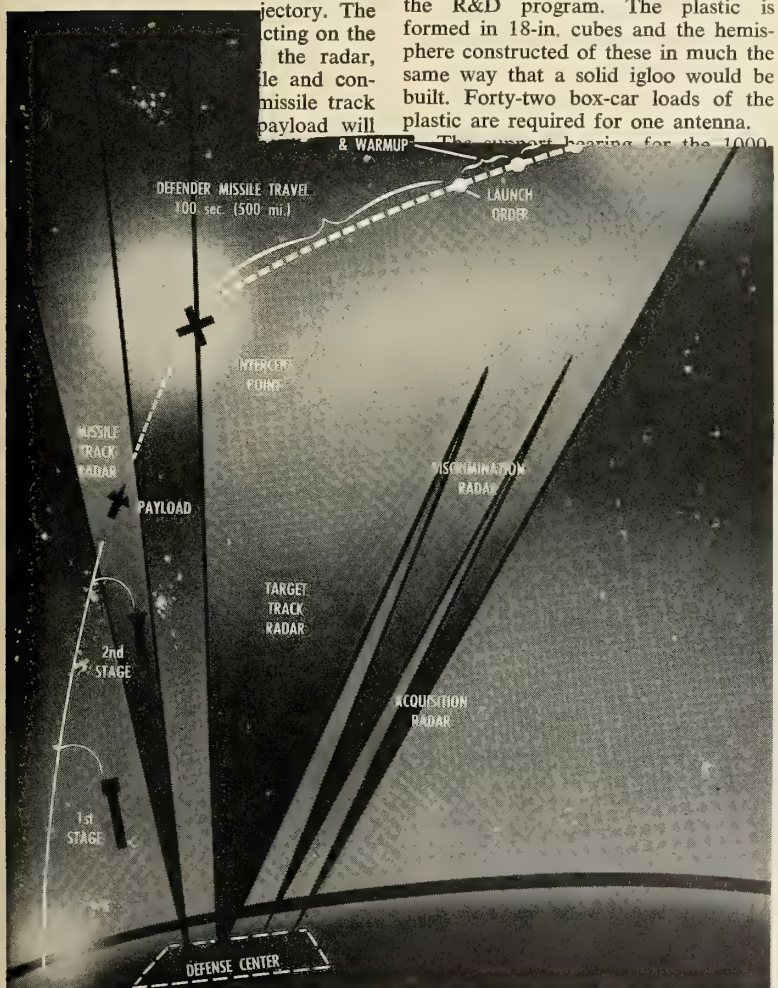
tallation, or acquisition, , and mis- s the com- control cen- isition radar ıe incoming n radar will separate out ion devices. lock on the jectory. The cting on the the radar, le and con- missile track payload will

unique application of a Luneberg lens. It is an 80-ft.-diameter solid hemisphere made of plastic foam impregnated with light slivers of metal. The slivers are distributed in the plastic in a very exact composition to vary precisely the dielectric constant. The metal-impregnated plastic acts very much like an optical lens, concentrating the returned radar pulses on multiple receiver horns inside the 110-ft. covering radome. The received information yields range, elevation, and azimuth data on the incoming target.

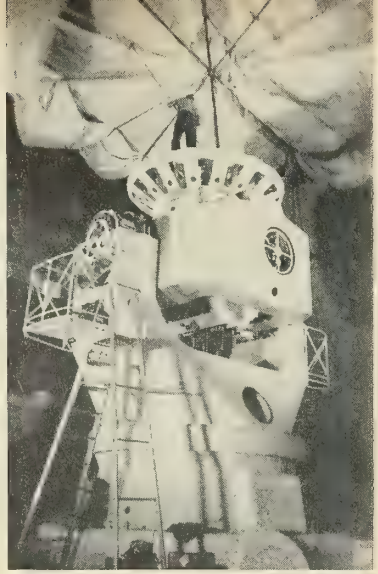
The ZAR receiving antenna incorporates several unique innovations in antenna design—as well as pushing the state-of-the-art in pure mechanical construction.

The most complex problem was the precise distribution of metal in the plastic foam. The solution is looked upon as one of the most important in the R&D program. The plastic is formed in 18-in. cubes and the hemisphere constructed of these in much the same way that a solid igloo would be built. Forty-two box-car loads of the plastic are required for one antenna.

The support bearing for the 1000-




*PARAMETERS OF HYPOTHETICAL interception show magnitude of problem of ICBM defense. Assuming warhead speed of 18,000 mph and interceptor speed of 7200 mph, system would have less than three minutes to acquire, define and establish trajectory of enemy warhead and deliver missile to intercept point. This means that primary acquisition would have to be made at ranges of 700-1000 miles.*



*FIRST MODEL of Zeus target track radar is installed at Ascension Island for tests against nose cones fired down Atlantic Missile Range. Huge mount—which barely fits in C-133 transport—weighs tens of tons. Accuracy of mechanical components is extremely critical to match*

could go into production tomorrow with a running start.

Bell Telephone Laboratories, responsible for R&D system design, has already overcome a host of first-magnitude technical problems. At first look, some of these certainly appear insurmountable. And many of *Zeus'* detractors are not convinced that they have been, or can be, solved.

But square-jawed Lt. Col. Glenn Crane, ARGMA's "Mr. Zeus," has a pat answer for the technical opposition to some of the advanced approaches involved in the program.

"Our detractors usually go through a three-stage metamorphosis," he says. "First, they state flatly that it can't be done. Then when they see us doing it, they admit that maybe it's not impossible after all. Finally, when the concept is fully proven, they will pat us on the back and say they knew all along that we could do it."

No one, pro or con, will deny that ARGMA bit off a large chunk when it set out to develop the *Zeus*. The system must be able to detect very small objects coming in from high above the atmosphere at speeds in the 15-20,000 mph bracket. It must identify and track multiple targets, and discriminate between real targets and decoys—and at speeds and ranges far beyond the capability of any other system. Finally, it must be able to launch and control defender missiles to intercept and kill the incoming warhead—at altitudes high enough to safely detonate a nuclear explosion without harm to the earth below.

Actual ranges and other perform-

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ance requirements of ICBM defense are, of course, classified. A look at a hypothetical problem will, however, give an idea of the problems involved. Logical assumptions as to speeds, travel and delivery items, radar characteristics, communications and computational requirements, etc., show that the operating parameters of such a defense system are enough to shake even the most optimistic designer.

• **System approach vital**—Army stresses the system approach as a large contributing factor in the success to date of the *Zeus* program. It contends that such a concept worked well in both the *Ajax* and *Hercules* systems and has been carried even further in the *Zeus*. To back this contention further, Army also points to Navy's *Polaris* and its ahead-of-schedule development. In fact, ARGMA is such an admirer of *Polaris* management methods that it has adopted a version of the Navy's PERT to prod its own program.

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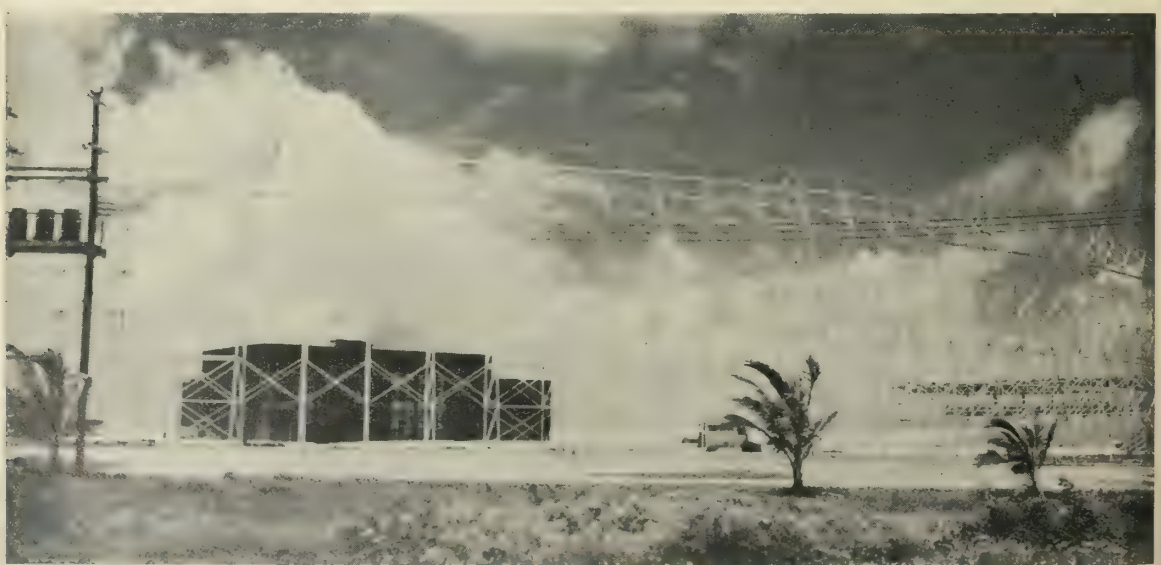
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The *Zeus* system is no collection of black boxes and off-the-shelf components that can be put together by an amateur on weekends. Without the system approach, design concurrency, and forceful and intelligent management, it is extremely doubtful that a program of this size could be put together in a millenium. The sheer magnitude and complexity of such a system with its problems in design, engineering, and production is enough to make its successful development seem impossible even to the initiate. The Army admits that the impossible does take longer.

The operational *Zeus* installation will be a vast complex of radars, command and control equipment, and missile batteries —all tied together by an extensive computer complex.

Radar is, of course, the prime component of the system. Several technical breakthroughs were necessary to get the equipment needed. Ranges, powers, precision, and discrimination capability are all beyond conventional radar performance.

Operational requirements for the antimissile system—speed, range, intelligence, accuracy—are of an order not encountered in any existing system. Total time available for the system to



*RADIO-FREQUENCY SHIELDING fence 65 feet high completely surrounds high-powered acquisition radar transmitter. Fence—to be covered with metal screen to shield personnel and equipment from potentially dangerous electromagnetic radiation —was designed after completion of an extensive survey of the radiation hazard by the office of the Army Surgeon General.*

accomplish its objective—from acquisition to intercept—is only a few minutes. The complete operation must be almost totally automatic since there is no time for human operators to control the equipment, make decisions, and issue commands. Consequently, the system is built around computers which evaluate incoming information and make intelligent decisions based on this operation. It is built to operate "hands off" from detection to kill.

An operational *Zeus* installation, or defense center, will include acquisition, discrimination, target track, and missile track radars as well as the computer and missile battery control center. In operation, the acquisition radar will detect and acquire the incoming warhead. The discrimination radar will "study" the warhead and separate out decoys and other confusion devices. The target track radar will lock on the target and establish its trajectory. The target intercept computer, acting on the information received from the radar, will launch the *Zeus* missile and control its flight through the missile track radar. The *Zeus* nuclear payload will be detonated on computer command at the intercept point, to kill the enemy warhead.

• **Acquisition radar**—The *Zeus* acquisition radar (ZAR) represents the most significant advancement in the entire concept. If any one part of the system can be said to be the most important, the ZAR is undoubtedly the one.

To detect and acquire a target the size of an ICBM warhead traveling at speeds of five miles per second at ranges of 700-1000 miles is undeniably a problem of the first magnitude. In addition, the radar must be able to provide track information on a large number of targets simultaneously. And the time available to accomplish this function is somewhere in the neighborhood of only 20 seconds. The acquisition radar was number one on the list of things-that-couldn't-be-done.

Due to the high output powers necessary, the ZAR uses individual antennas 1000 feet apart to transmit and receive.

The transmitting antenna is a flat triangular arrangement of three arrays, each about 80 ft. long. It rotates 360 degrees in azimuth and is mounted atop the half-buried hangar-size transmitter. A circular radiation-shield fence surrounds the entire two-story transmitter installation. Actual output powers are classified but they are in the multi-megawatt range. (Cornell Aeronautical Lab, under ARGMA supervision, just recently built a 50-megawatt microwave radar for research into ICBM detection and tracking.)

The ZAR receiving antenna is a unique application of a Luneberg lens. It is an 80-ft.-diameter solid hemisphere made of plastic foam impregnated with light slivers of metal. The slivers are distributed in the plastic in a very exact composition to vary precisely the dielectric constant. The metal-impregnated plastic acts very much like an optical lens, concentrating the returned radar pulses on multiple receiver horns inside the 110-ft. covering radome. The received information yields range, elevation, and azimuth data on the incoming target.

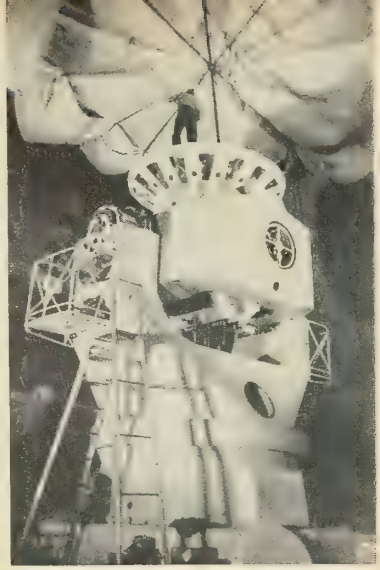
The ZAR receiving antenna incorporates several unique innovations in antenna design—as well as pushing the state-of-the-art in pure mechanical construction.

The most complex problem was the precise distribution of metal in the plastic foam. The solution is looked upon as one of the most important in the R&D program. The plastic is formed in 18-in. cubes and the hemisphere constructed of these in much the same way that a solid igloo would be built. Forty-two box-car loads of the plastic are required for one antenna.

The support bearing for the 1000-ton antenna is one of the largest ever made. Thirty feet in diameter, the bearing has an accuracy tolerance of 0.0005 in.

The receiver uses a maser amplifier to give the system an extremely low overall noise figure (about 4°K).

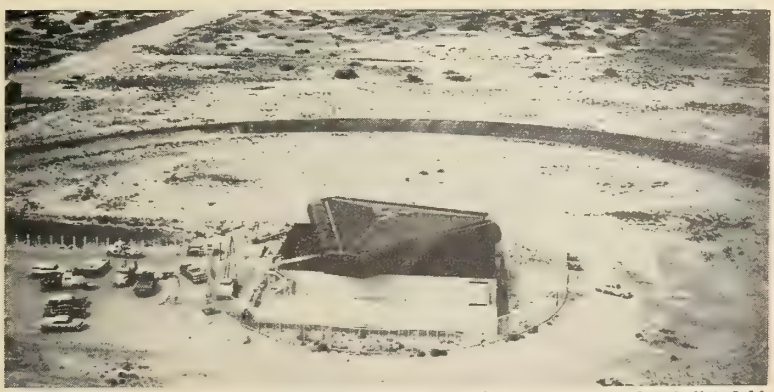
• **Discrimination radar** — Development of the vital discrimination radar (DR) was another of the complicated problems besetting the *Zeus* team. In fact, the whole problem of discrimination is one not yet entirely solved and requiring a great deal of research in the future. Continuing inputs from the *Defender* program, including data from Army's DAMP (Down-range Antimissile Program) and PRESS (Pacific Range Electromagnetic Signature Study) are expected to shed further light on the problem. During the next year, ARGMA's schedule calls for an expansion of data from DAMP, collection of actual tracking data with *Zeus* radar, and the tracking of decoyed shots.



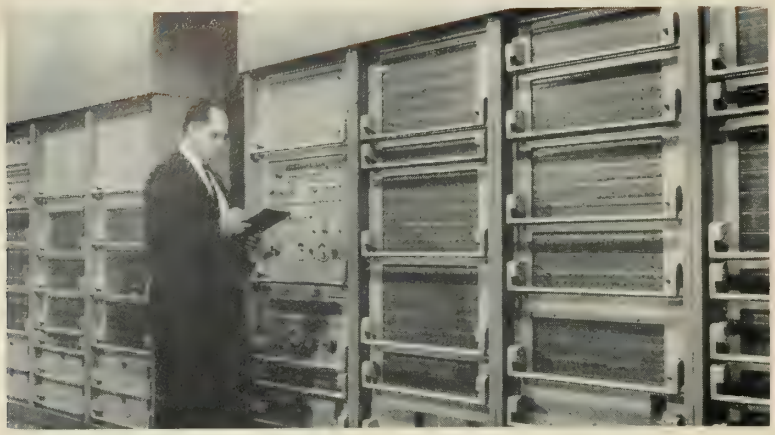
*FIRST MODEL of Zeus target track radar is installed at Ascension Island for tests against nose cones fired down Atlantic Missile Range. Huge mount—which barely fits in C-133 transport—weighs tens of tons. Accuracy of mechanical components is extremely critical to match precision of overall system.*

ARGMA's approach to the discrimination problem is not to depend on any one technique nor to apply any one technique at just one point. Many promising methods are now within the state of the art and others are expected to come along in the near future.

An Army spokesman recently said: "The art of discrimination today consists of a solid array of theories on a broad front—now we must collect the



*TRANSMITTING ANTENNA of Zeus acquisition radar is as big as a baseball infield. Mounted on top of its transmitter, the antenna rotates at 10 rpm to sweep the sky for oncoming ICBM warheads. This installation at White Sands will be used in research and development system testing.*



**LEFT:** *Developmental model of Nike-Zeus target intercept computer. System is a high-speed, general-purpose, digital computer with a large variable memory capacity.*

**RIGHT:** *Target intercept computer rear view shows arrangement of stacked C-planes and array of air-conditioning ducts.*

**FAR RIGHT:** *Guidance test console (at left) is shown during checkout of a guidance section before installation in third stage of Nike-Zeus.*

necessary tracking data using actual *Zeus* equipment rather than just laboratory synthesis."

Army stresses highly the joint efforts expended on the discrimination problem in cooperation with the Air Force. ARGMA maintains liaison officers at both Vandenberg AFB and AFBMD headquarters. The two services work together on decoys and discrimination, nose cone design and signatures, firing schedules for DAMP, and long-range cooperation of the *Zeus* radar on Ascension Island.

Army provides AF with signature data to help them in nose cone design. AF passes on to Army decoy development information and booster fragmentation data for radar tests. And, of course, both cooperate on firings of the AF *Atlas* in a double-barreled effort which serves to train AF crews as well as provide targets for *Zeus* tracking and intercept.

Details on the *Zeus* discrimination radar are pretty tightly bound up in security. Primary feature of the variable-beam antenna used is its great data-handling capacity. The transmitter uses a multi-megawatt klystron power amplifier tube developed specifically for *Zeus*.

• **Target track radar**—The needle-beamed target track radars (TTR) take over automatically once the target is located by the ZAR. They furnish continuous precise trajectory information to the computers to determine the intercept point.

The TTR uses a 25-ft.-Cassegranian reflector in a 40-ft. radome. Basic features of the radar are its range versus small target radar cross-section, very narrow beam, and extreme accuracy. Its huge mount weighs in the tens of tons and is reportedly the most precise ever produced. The *Zeus* TTR was used in the recent successful missile kills by the *Nike-Hercules*.

• **Missile track radar**—The missile track radar (MTR) tracks and guides the *Zeus* missile to the intercept point, and commands its destination. Tracking is achieved through a beacon in the third stage. Design of the MTR—described by ARGMA as "a relatively simple job"—is a direct outgrowth of the *Hercules* track radar.

• **Target intercept computer**—The brain connecting the flow of information to and from the radar complex monitoring an incoming ICBM and directing the defending *Nike-Zeus* is the target intercept computer (TIC).

Simply stated, its role is to solve the guidance and control problem for successful intercept of anything from a single attacking warhead to a salvo employing decoy tactics.

Western Electric and the Army believe that TIC will do the job. More importantly, its design is flexible enough to do it well into the future—as state of the art is advanced for AICBM's, ICBM nose cone design, and decoy techniques.

The computer is a high-speed digital system employing all the tricks of built-in reliability. A design goal of 0.01 failure per 1000 hours operation for high-speed switching transistors and deposited-carbon resistors gives an indication of the severe requirements to be met in fabrication.

In testing transistors during the extended reliability studies, over 160 million hours test time have been accumulated, during which there occurred a total of only 7 hours failure time.

• **Fabrication unique**—Over 90% of the computer system is comprised of one standardized electronic package. Called an "A-module," these cigarette-package-size units are assembled in horizontal racks designated "C-planes." These in turn are stacked and connected in drawers called "D-modules."

All electrical connections employed in the system are made using the "wire-wrap" technique to avoid solder connections. With over one-half-million A-modules used in a single system which requires more than 20 million connections, the wire-wrap method eliminates the danger of faulty connections and is applicable for automation.

The module assembly approach, too, lends itself to automated fabrication and inspection. Also, it later simplifies maintenance and unit replacement in the field.

The computer is capable of 200,000 arithmetic operations per second (roughly 20 times better than a standard high-speed business computer).

It employs a variable, permanent-memory device comprised of elements called "twistors." The twistor, which consists of tiny bar magnets and extremely fine wires wrapped with magnetic metal tape, is another recent Bell Labs development. Although new, its production already has been automated.

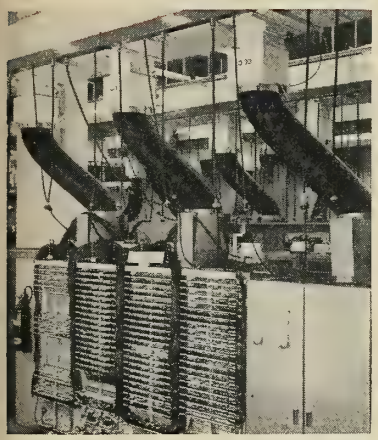
Acquisition of data from storage requires about 2.8 microseconds.

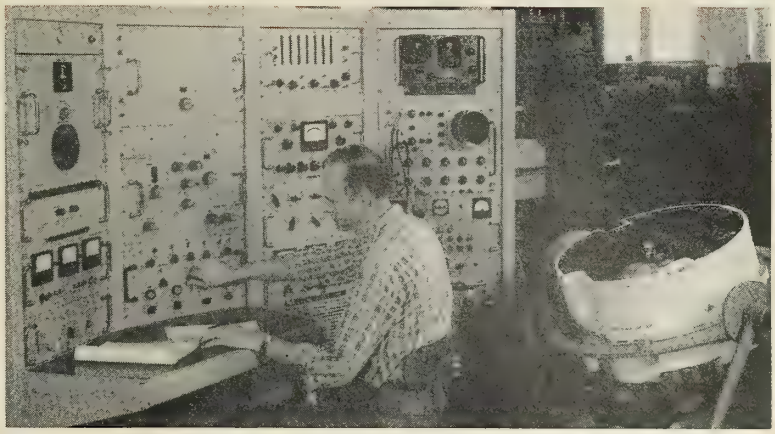
• **Radar/computer processes**—The guidance computation problem starts with ZAR when it detects and acquires probable targets. The radar outputs are fed into the detection data computer at a *Zeus* defense center.

A battery is assigned responsibility and first inputs are fed into its target intercept computer. The battery discrimination radar is engaged and the identification process begins.

Using a variable-beam antenna, the DR employs its long range, short pulse-width, and multiple-frequency transmitter to obtain a reflected identification of the approaching vehicles.

By extremely sophisticated processing, these data will be separated and





compared with all the known identification characteristics held in storage within the computer.

Discrimination, in over-simplified terms, can be compared to sorting apples. Radar information received from the target is shuffled down through various "screens" by the computer, sorting it out according to various programed parameters. Based on known characteristics of ICBM warheads, the incoming data are dumped into various trays and classified until, by a process of elimination, the real target is identified and the trash discarded.

It is the collection of this mass of meaningful signature characteristics that has received such a concentrated effort during the past two years from both the Army and the Air Force.

• **TTR and missiles assigned**—When an approaching vehicle is identified as a probable target, the computer assigns a target tracking radar, assigns particular *Zeus* missiles for a defensive salvo, and initiates missile warmup.

Reaction time is paramount at this point, for such vital components as the power supplies and gyros must be ready ahead of the launch order.

## *Technical Breakthroughs in Zeus Development*

- Low-noise receiver
- CHIRP (Signal Compressor technique).
- Twistor (Computer permanent memory device).
- Super-power klystrons.
- Luneberg lens media.
- Production techniques for computer components (A1-modules and C-planes).
- Mass production of high-reliability transistors.

Data received from the TTR is then analyzed to compute the time of flight and determine *Zeus* initial intercept trajectory and burst point. These data are then fed from the computer to the missile tracking radar assigned to each *Zeus* missile.

The missile tracking data and *Zeus* guidance inputs are under continuous refinement. At the computed time, the launch order is generated by the computer and the salvo first-stage rocket engines ignited.

Principal intercept corrections, once the birds are in flight, are made just seconds before reaching the planned intercept point.

Missile arming and fuzing occurs only when a series of safety requirements have been met (altitude, speed, etc.).

Finally, the computer issues the burst order and then clears for the next defensive action.

• **Missileborne guidance**—One of the great advantages in any radio-command guidance system is relative simplicity of the missileborne guidance package. *Zeus* is no exception, although somewhat more flexible in its capability.

Electronics in the third stage is standard, consisting of the transponder or radar beacon, command receivers, gyro reference platform, control system, power supply, timers, and associated circuitry.

The reference platform is a fully gimballed system employing three 1-degree of freedom gyros.

Control by the missile tracking radar on the ground is accomplished by means of the transponder (for tracking) and the command receivers (for guidance orders).

Power for the third-stage electronics is from a battery pack. Hydraulic actuation for control of the four external vanes on the warhead is by a hot-gas turbine. This same system also controls the third-stage rockets for omnidirectional control in the extra-atmosphere.

No terminal homing is employed, because of the need for an ablative nose-cone during missile exit. Use of such a system might be desirable but is currently beyond the state of the art.

• **Manual override**—The entire *Nike-Zeus* weapon system is fully automatic, but human intervention is possible at any time.

At the battery control centers, consoles provide three-dimensional screen displays for monitoring defense operations. Here also is located a manual override whose use is discouraged but nevertheless is available when necessary.

Also located in battery control are extensive troubleshooting panels. These indicate maintenance status for all of the electronic equipment and indicate which particular rack and drawer is defective upon failure. Additional indicator lights on the equipment racks more precisely locate faulty units.

• **Automatic checkout** — Heart of the checkout system is Stromberg-Carlson's SCATE (M/R Sept. 21, 1959; p. 54). The automatic checkout system is a fully transistorized, high-speed system which uses Mylar punched tape for programing.

The equipment has been completely integrated with the ground and missile guidance system. It provides constant monitoring and scanning of sensitive test points, a go/no-go readout, visual and printed, and includes fault prediction analyses.

A supplement to the unit is an r-f test set used to test the missile-borne guidance package. It is remotely controlled from the master control panel at the battery control center. ⌘

NIKE-ZEUS

# Speed-up Of Missile Output Would Be Simple

***Douglas and Thiokol see no major difficulties in expansion; support equipment is also well advanced***

**by William J. Coughlin**

THE LEAST COMPLICATED aspect of the *Nike-Zeus* development program is the missile itself.

Many production problems already have been solved at Douglas Aircraft Co., in turning out the several hundred missiles needed for the research and testing phases.

On the propulsion side, Thiokol jumped from a 3.5-in. scale motor to a full-scale *Zeus* booster without any intervening models—or trouble.

Douglas says that a step-up in production to the numbers currently being discussed would require only a slight expansion of facilities at the Torrance plant of the El Segundo Division.

"The problems, if any, are of the nature of trimming a resistor or beefing up a frame," says R. L. Johnson, chief engineer, Missile and Space Systems. "They are of the type that do not require drastic changes in design, production facilities or support equipment."

• **Tempered optimism**—Complexity of the *Nike-Zeus* system lies in its computers and radars, Johnson points out. Production of the missile can be increased to whatever numbers are desired well within the time span required to step up production of the electronic equipment.

"We also are further ahead with support equipment—launchers, shipping containers and test sets—than we were with *Nike-Ajax* and *Hercules* at this stage," Johnson adds. "We feel we know more about *Nike-Zeus* than we did on either of those."

This optimism is coupled with the caution that not all problems are solved yet—or even known.

Although 48 1/3-ft.-long *Nike-Zeus* is a fairly straightforward design, it does have some unusual features requiring production techniques which are pushing the state of the art.

These include:

–Insulation of the entire missile with exception of the booster. Application of this to the aluminum missile requires special tools and techniques.

–Motor case production from high-strength modified 4340 steel. Several years study have been necessary to develop the know-how and equipment for this.

–Use of large plastic nozzzles. In the case of the booster this means a 42-in. bell. At the time development of these was begun, the techniques required were well in advance of the technology.

Major design objectives were to hold down weight and size of the missile and to improve its flight time to target. Douglas engineers settled on aluminum shielded with ablative material, with high-strength steel for motor casings.

The booster, which has a burning time of 5 sec., is of conventional design with a plastic nozzle and aluminum fins. The sustainer likewise is of high-strength steel. The nozzle also is plastic and the aluminum fins are covered with ablative material.

• **Third "cousin"**—First two stages of *Nike-Zeus* have been deliberately kept simple, N. T. Weiler, chief project engineer, notes. All of the headaches have been saved for the third stage.

A spherical, third-stage solid-propellant motor provides forward thrust and out-of-atmosphere control through the missile's cannard-design "jetavator" control system. Control within the atmosphere is aerodynamic. The third-stage engine is not used to gain velocity —as in a conventional ballistic missile —but primarily for control.

"It's a first cousin to a third stage but you can confuse people by use of the term," Weiler warns. For intercepts within the atmosphere the final stage does not separate from the sustainer.

Base section of the "jethead," or third stage, contains the guidance system and the inert quick-activating battery airborne power supply. Small external fairings in this area are antennas.

Forward of the guidance system is

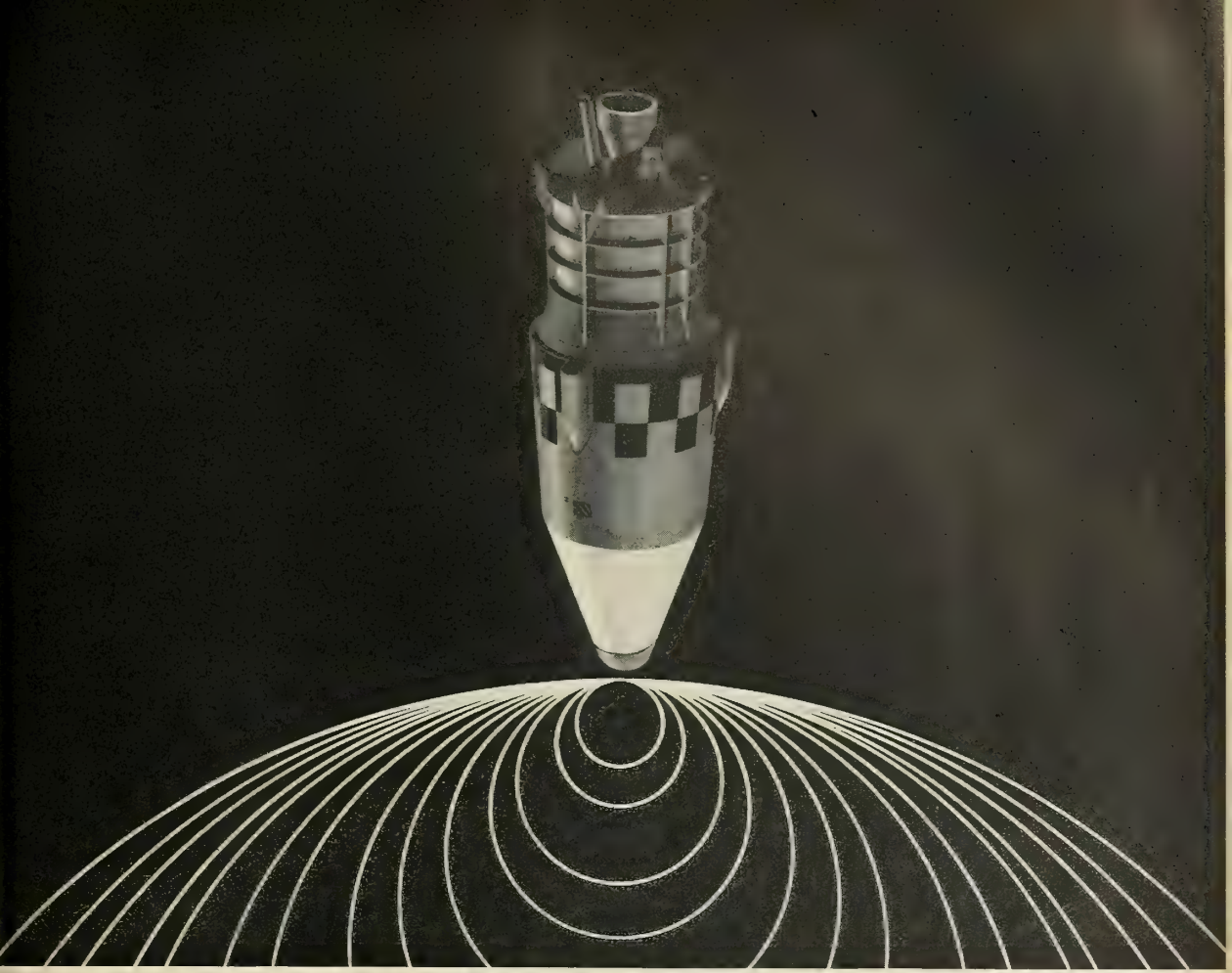
*(continued on page 41)*



*CYLINDRICAL CHAMBER for the Zeus third stage guidance propulsion unit has its loading area diameter checked by a Douglas Aircraft Co. technician.*



Circle No. 11 on Subscriber Service Card.



# "MIDAS" REPORTS

**through communications equipment by Philco**

MIDAS II, the experimental "sentry in space," is the forerunner of a series of satellites that will detect the launching of ballistic missiles anywhere on earth and instantly relay the warning. Its entire communications system was designed and produced by Philco's Western Development Laboratories for the U.S. Air Force, as associate contractor with Lockheed.

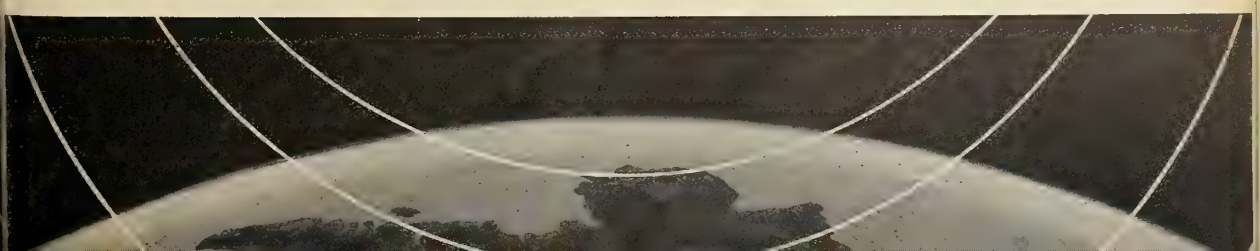
This is another example of Philco's leadership in advanced electronics that is contributing to our national defense . . . in satellites, missiles, weapons systems, communications and data processing. For vast capacity, facilities and experience, look to the leader . . . look to Philco.

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CREATIVE ELECTRONICS BY RCA



# KEEPING BMEWS ON THE AIR

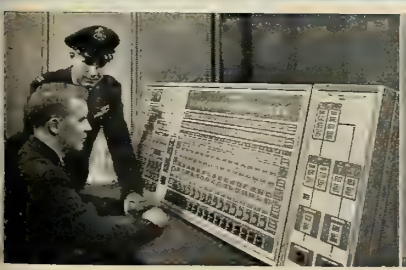
## RCA Checkout and Automatic Monitoring Equipment Guards BMEWS Reliability Around the Clock

The incredible complexity of the BMEWS network and its vital mission in continental defense demand the ultimate in system reliability. Through unique and highly advanced developments by RCA this standard is being achieved.

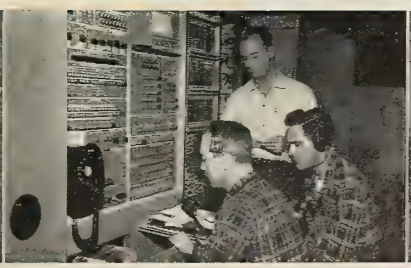
The RCA Checkout Equipment installed at BMEWS sites performs a dual function—it generates and inserts realistic simulated target problems for on line exercising of the entire system. These integrated tests are designed to test the BMEWS early warning capability to its fullest extent. Automatic monitoring detects degradation prior to failure and isolates marginal conditions or malfunctions enabling rapid corrective maintenance.

Around-the-clock operation of this RCA equipment enables BMEWS to meet its over-all operability goal with negligible downtime, thus keeping BMEWS on the air!





**The Central Automatic Monitoring Console** displays the status of the entire site, and displays equipment degradation prior to failure.



**The Checkout Data Processor** generates simulated missile attacks and evaluates the BMEWS response to the simulation



**The Automatic Monitoring Console** displays degradation and the location of degraded equipment.

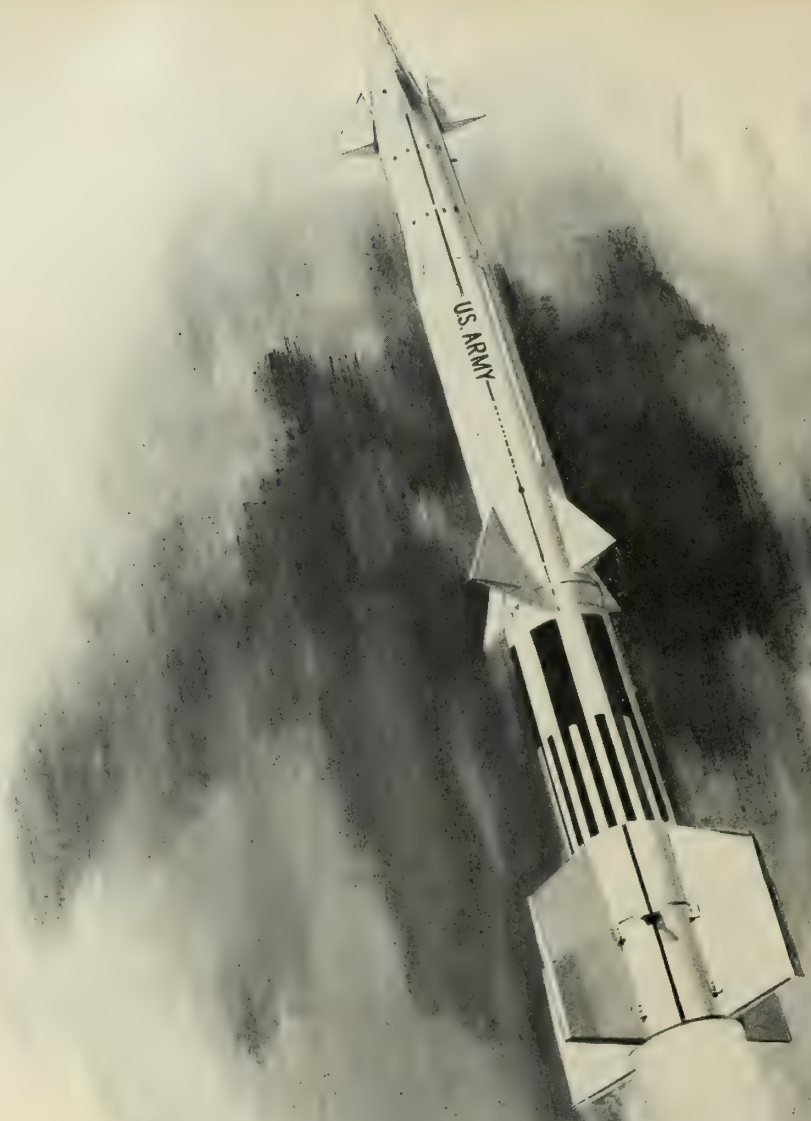
RCA Checkout and Automatic Monitoring (CAM) Equipment has greatly enhanced the reliability of complex ground environment systems. Adaptable for use in systems already completed, and as an integration tool for systems currently being implemented, CAM equipment is available for all complex commercial, military, and government systems. For a description of the RCA Checkout and Automatic Monitoring Equipment, write to: RCA Major Defense Systems, **Defense Electronic Products,** CAM 127-204, Moorestown, New Jersey.

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# Megawatts for NIKE ZEUS...

With a booster of over 450,000 pounds of thrust, NIKE ZEUS will need still another form of power to fulfill its anti-missile assignment. This other power is in millions of watts – energy for the system's extended range target tracking and discrimination radar transmitters.

Developed for the Army by Sperry out of its long experience in high power radars, and employing giant-wattage Sperry klystron tubes, the target tracking transmitters will permit greater-than-ever capability for radar tracking of "hostile" targets. The discrimination radar is designed to classify targets according to the nature of the threat.

NIKE ZEUS – the nation's only anti-missile missile system now in the advanced development stage – is undergoing R&D and pre-production programming under the Army Rocket and Guided Missile Agency (ARGMA) cognizance, with Western Electric as prime contractor and Bell Laboratories responsible for the overall system. It is the only missile system now in development for intercepting ICBM's . . . to defend our cities and defense sites.

SPERRY

**SURFACE ARMAMENT DIVISION,** *SPERRY GYROSCOPE COMPANY – DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N.Y.*



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(Continued from page 36)

the hydraulic auxiliary power unit—an AiResearch solid propellant gas generator. Above the APU is the third-stage engine and then the hydraulic control system for the fins. Final item, of course, is the nuclear warhead.

• **Straightforward production**—Engine cases are fabricated at the Torrance facility from steel sheet. This is inspected ultrasonically and then rolled on conventional equipment into half cylinders. These are trimmed, joined and welded longitudinally with an automatic inert gas shield arc.

Domes are conventionally deep-drawn. Douglas is experimenting with explosive forming for final configuring, not only for domes but for spherical motor case in the jethead. The domes are formed with an opening for the igniter boss, with some machining of this and the attach points. Cones for nozzle attachment at the opposite end of the motor case are machined from a forging.

Douglas has developed a unique nozzle attachment said to be about half the weight of a conventional bolt joint. This involves use of flexible steel, with no stress on the nozzle attach points until actual firing of the motor.

Before the dome and nozzle are attached to the case by roll seam welding, the case goes into a sizing machine. Here, a series of segmented mandrels expand it to given diameter.

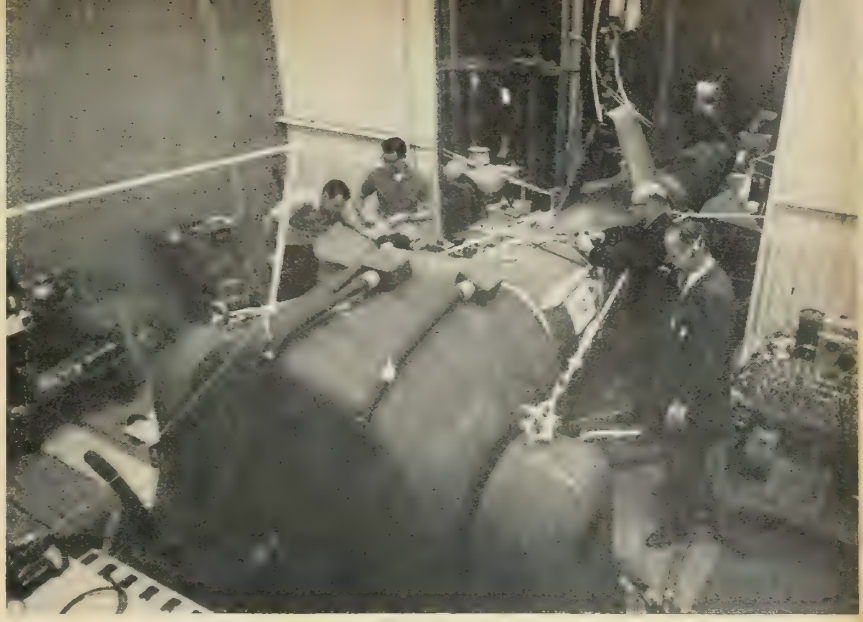
The igniter boss, machined from a forging, is welded to the dome; the case is heat-treated in a vertical gantry-type cylinder. This is a conventional quench and draw process under closely controlled conditions.

Final trimming on the igniter boss and nozzle attach joints is done with the case in a large lathe. Aluminum alloy frames for attachment of adjacent missile sections then are lock-bolted on.

Interior insulation of the sustainer is cured in place under heat and pressure after being laid in at the ends of the cases. Interior booster insulation is done at Thiokol.

Douglas reports actual proof testing of these cases to 237,000 psi. Two were cycled at this figure for over 100 cycles with no failure. With firing pressures of 217,000 psi, Douglas engineers are hopeful of going to a lighter weight and less expensive case material.

• **Propulsion breakout**—For an interim period, Grand Central Rocket is providing propellant for the sustainer and third stage and Thiokol for the booster. In mid-year, Thiokol is to be phased in on the other two stages. During the research and development period, cases are shipped to Thiokol for loading. Production loading will be at the Charlotte, N.C., arsenal.



*MASSIVE SHAKE TABLE simulates flight vibrations in the Nike-Zeus jet head.*

The third stage is manufactured in the standard airframe approach with some formed and some machined frames covered by 24ST aluminum alloy welded into a cylinder. This stage is manufactured in four sections, for ease of access to interior equipment. The jethead has a minimum of access panels due to high temperature encountered in flight.

Details of plastic facilities used for turning out the lightweight nozzles are classified; Douglas feels that the drastic reduction in weight over equivalent steel nozzles—some 50%—amounts to a breakthrough. But the method used is known to involve helical winding of fiberglass filaments onto the nozzles after application of glass cloth.

A. J. Carah, *Nike-Zeus* design engineer, says the Torrance facility as now equipped could not quite meet production numbers presently under discussion. A new heat treat furnace and additional welding equipment would be among the items required.

"But we could start production right now and build up to a fairly substantial rate quickly," he asserts.

Production of the third stage and final assembly of the production missile will be at the Charlotte arsenal, where *Nike-Zeus* will be checked out as an integrated unit and then shipped to site or depot as required. ⌘



*FINISHED MOTOR CASES for Nike-Zeus booster stage are stored for future use.*

# Missile Has Special Protective 'Skin'

by Dr. R. M. Wood and T. J. Ashley*



*EPOXY GAP FILLER is applied to longitudinal crevice between insulative sheets on Nike-Zeus section.*



*FILLED AREAS are blended with surrounding coating by sanding after heat cure. Base is Shell's Epon 828 resin.*

A UNIQUE FEATURE of the production of *Nike-Zeus* was the development of the insulative shield which covers the missile's entire metal exterior—a coating made necessary by the extreme acceleration *Zeus* must achieve immediately after lift-off in order to meet its target on schedule.

Flat sheets or molded shapes of phenolic/nylon are bonded to all surfaces of small angle of attack. Phenolic/Refrasil covers leading edges and other areas subject to high aerodynamic shear and pressure forces.

The severe aerodynamic heating encountered during the booster stage of flight requires that all gaps, joints, holes and surface imperfections in the insulation must be repaired or thermally protected to prevent damage to the missile structure beneath.

Gaps are inevitable, in spite of the close-fitting sheets. Normal manufacturing tolerances in the fabrication of flat and molded parts also create difficulties.

• **Perfection a necessity**—In some areas of the missile the heat flux rate varies greatly with geometry. Weight can be cut significantly by permitting the insulation thickness to vary with the geometry and heat flux rate. For these areas, parts are molded to contour. Butting molded parts to flat sheets invariably produces gaps which are as deep as the coating and up to 1/8-in. wide.

Holes also are a problem. After the missile structure has been produced, technicians must be provided access to to the interior of the missile to make adjustments and to install various pieces of equipment and telemetry hardware. Access openings are provided in the skin to permit entry. When all work finally is completed, the openings are sealed by means of panel doors which are bolted in place. Bolt holes in the insulation are as large as the boltheads, and may be as deep as the protective coating. Holes must be filled flush with the coating.

In addition to gaps and holes, there is also the possibility that the coating may be gouged or scratched as a result of handling while the missile is in transit to the launching pad. Damages of any kind to the coating must be repaired before the countdown button is pushed.

Considering the insulative requirements of the protective coating, the material selected to fill gaps and holes has to perform as well or better than the coating itself. During flight the outer surface of the insulative material will be heated to an ablation temperature. At this temperature it begins to decompose and the surface regresses. At no time should the gap filling compound deteriorate faster than the coating, nor debond; otherwise, aerodynamic heating could affect the metal skin of the missile at those points.

Normally, it is not required that the gap filler be the same density as the primary thermal insulating or ablating materials. This is because the gaps and bolt holes represent a relatively small area over the missile.

Even if the density of the filler were quite high, it would not represent a critical weight factor because only small amounts of materials are applied.

The gap and hole filler used on the *Nike-Zeus* is a heat-resistant, classified formulation developed in the Douglas Materials Research and Process Engineering Laboratories. It is a composition based on Shell Chemical Co. Epon® 828 resin and cured with diethylenetriamine. It has low shrinkage, good mechanical strength and excellent adhesion to metals and reinforced plastics. While good room-temperature cures can be achieved, Douglas prefers to apply heat to speed curing—especially in the field. Large furnaces are employed in-plant; heat lamps are used in the field. The epoxy material is easy to prepare and can be applied with relatively simple equipment.

• **Caulking Zeus**—Gaps in the protective coating are filled with a pneumatic gun where two pieces butt together, and by hand where complex molded parts are faired into sheet material. The epoxy gap filler is prepared in both cases by mixing only the amount of resin and curing agent that can be used within a certain period.

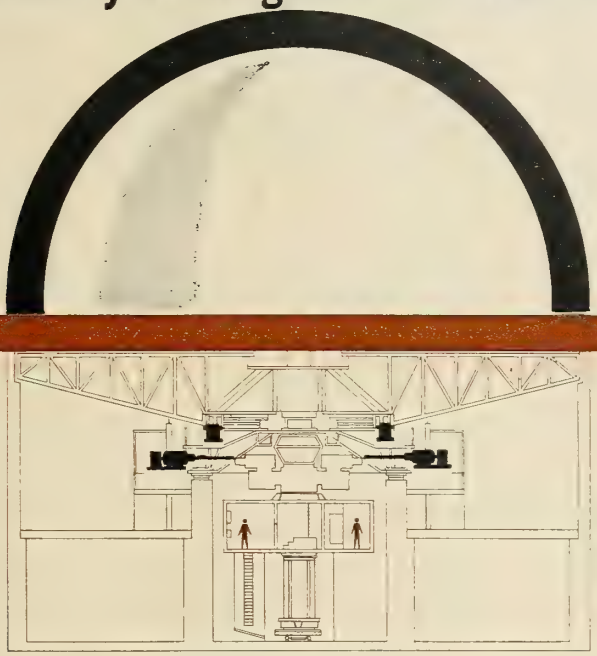
For gun applications, the mixture is loaded into a Teflon container which is reusable because the resin will not adhere to this plastic unless the latter is especially treated. The container is then placed in a metal barrel which is attached to the trigger mechanism. After the Teflon filler tip is screwed into the container, the gun is ready for use.

The epoxy filler is pumped out of the tip, the end of which is fitted with a washer to smooth the resin as it emerges. When the resin has cured, the filled areas are sanded to blend with the surrounding protective coating. Holes and surface imperfections are handfilled with the epoxy material and sanded smooth after cure. ⁂

* *Chief, Thermodynamics and Nuclear Science Section, and member, Missile Experimental Thermodnamics Group, respectively, Douglas Aircraft Company, Inc.*



# adar Antenna Drive by Westinghouse for Nike-Zeus* on Kwajalein



On some undisclosed date in the future, the free world's only anti-ICBM missile system now in development—the U. S. Army's Nike-Zeus—will face another critical test.

A Nike-Zeus complex located on tiny Kwajalein Atoll in the Pacific must detect, track and kill oncoming ICBM's. USAF crews will fire the would-be enemy (Atlas) missiles from Vandenberg AFB.

One of the key performers in the spectacular intercept will be 1250 tons of Acquisition Radar standing several stories high. Westinghouse is supplying the antenna drive motors and controls and a 30′ dia. hydrodynamic thrust bearing under subcontract to Goodyear Aircraft Corp. Westinghouse is one of the few companies, anywhere, that could manufacture a bearing of this size.

Imagine the demand for precision accuracy and delicate maneuvering to get the jump on an ICBM. Tolerances for the bearing were extremely exacting: sectors of the 30′ diameter segmented bearing must be held flat within .0005″.

Westinghouse can supply complete drive systems and mechanical components for just about any type of radar antenna. From a simple AC drive for continuous scanning on up to complex solar exploration radar. We provide the complete package: motors, gearing, controls, thrust bearings, etc.

So relay your requirements to Westinghouse . . . via the local Westinghouse sales engineer or by writing direct: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse. J-92508

*Prime Contractor: Western Electric Co./Bell Telephone Laboratories.

Westinghouse

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# 'The Sun Never Sets' on Zeus Testin

## *Army insists on most rigid possible test program, but no frills; $90 million so far for brick and mortar*

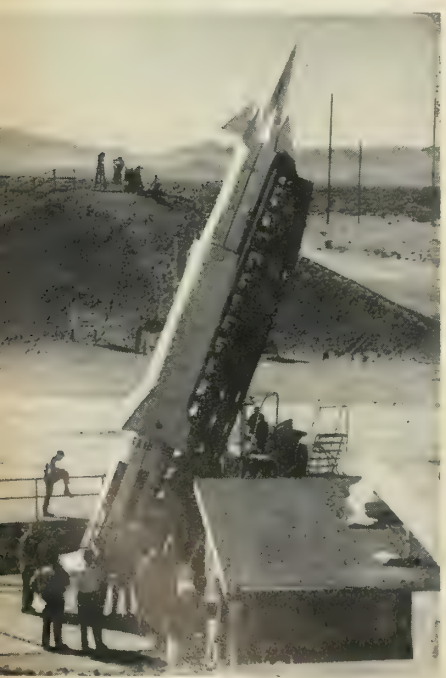
by John F. Judge

*NIKE-ZEUS* testing sites are scattered halfway around the globe. Facilities are in operation or under construction to check out every aspect of the complex antimissile missile system.

The massive test program is designed to complete *Zeus* system development in the shortest possible time. Simultaneous testing of various components is under way from Ascension Island in the South Atlantic to Kwajalein Atoll in the Pacific's Marshall Islands.

Approximately $90 million has been spent to date for brick-and-mortar type construction alone at all test sites. The Army's Corps of Engineers is handling the construction job.

No frills have been added to the task of checking out the system. "The Army is real hard-nosed about gold plate," says one contractor. Each site was chosen with care. For example, 18 locations in the Atlantic and 33 in the Pacific were considered before Kwajalein was picked.



*ZEUS being readied for test firing.*

• **Checkout problems**—*Nike-Zeus* differs from the rest of the *Nike* family in that the system must "see" the enemy object much farther away and with greater accuracy. And this object is traveling at ballistic speeds.

To compound the testing problem, *Zeus* is designed to combat future warheads including those re-entering at speeds greater than Mach 15. A wide spectrum of targets are incorporated in the *Zeus* design.

Ultimate proof of *Zeus* will come in actual engagement of incoming warheads. The Air Force is cooperating closely with the Army in the design and construction of "special" targets to be launched with *Atlases* from Vandenberg at the tail end of the testing program.

This entails the *Zeus* system actually "defending" Kwajalein Atoll against America's operational ICBM's.

Major test facilities include:

• **Bell Telephone Laboratory, Whippany, N.J.**—Computers simulate "flying" the birds in the "Blue Room"—named after the color of the walls. BTL is equipped with a large radar complex. Scientists in the Basic Systems Design Group have a backyard capability to checkout the complex gear to determine if it lives up to design predictions. A *Zeus* Target Intercept Computer (TIC) is currently being installed.

Backed by years of similar effort in the overall *Nike* programs, the Whippany complex has saved the *Zeus* project "countless" dollars in the live firing tests alone by investigating every conceivable aspect before actual ignition. Such simulation flights checked out very closely with live test shots in the *Hercules* program.

ARGMA considers Bell's work in this area as the most important single aspect of the entire test program.

• **Ascension Island**—Ballistic missiles fired down the Atlantic Missile Range from Cape Canaveral soon will be tracked by highly accurate radar equipment. A *Zeus* Target Track Radar (TTR) has been installed and energized. Its dish antenna measures 25 ft. across and a plastic radome houses both it and its 200,000-lb. mount.

Information on the radar characteristics of incoming warheads will be recorded on magnetic tape by a computer. Data from ARPA's DAMP (Downrange Antimissile Program) ship and two Air Force instrumentation vessels will supplement the TTR acquired information. The *Zeus* TTR data will be fed into computers at White Sands and Point Mugu to check on the accuracy and reaction time of the *Zeus* system. The tapes will simulate an ICBM target, providing the *Zeus* missile with the location of the warhead and intercept points. At White Sands and Mugu, *Zeus* missiles will be fired and recording instruments will indicate its success in intercepting the "ghost" target based on information fed into the target intercept computer by the Ascension Island tapes.

The TTR at Ascension is expected to be operational by mid-1961. Its recorded data also will be given to the Air Force.

• **White Sands, N.M.**—Partly finished, this *Zeus* facility includes a complete radar complex, launch cells, battery control and necessary data processing equipment. The range has a size limitation allowing only the firing of the first two stages of *Zeus*. Thus the testing of the missile up to and including second-stage firing and control generally defines the range's mission.

Firings are conducted over White Sands Extension, a 40-by-40-mile section leased by the Army. But the tests may be run only at specific times—never during the lambing season. The handful of residents living in the area insisted upon this provision in their lease to the Government.

Designated *Highball I, II,* and *III,* these new tests here will consist of radar checkout objects boosted to altitudes over 100,000 ft. by *Asp-Apache* research rockets. The series was developed by the Physical Sciences Laboratory, New Mexico State University.

Payloads will be parachutes, balloons and other items designed to check out radar equipment with respect to target cross-section, multiple targets and the like. A B-47 will be tracked to trim the radar.

• **Point Mugu, Calif.**—This year all three stages of *Zeus* will be fired for the first time down the Pacific Missile

# acilities

Range. Two launch sites, Missile Tracking Radar, Target Intercept Computer, associated data processing equipment and control facilities have been installed. The facility is purposely being kept as austere as possible, utilizing all available existing buildings and equipment.

• **Kwajalein Atoll**—Showdown tests of the *Zeus* system will take place over this tiny Pacific islet. *Zeus* missiles will be fired at re-entering warheads launched from Vandenberg AFB. Firings are expected to commence within 14 months.

The antimissile system will face two categories of targets: regular warheads and special nose cones developed specifically for *Zeus* tests. Equipment is now being installed to test out all the items in the *Zeus* system.

Every test at Kwajalein will be a complete system test. Facilities include telemetry sites on the neighboring islands of Ennylabegan, Gugegwe and Roi-Namur. A communications repeater station at Eniwetak and a boresight tower at Ennylegaret complete the ground stations.



*KWAJALEIN ZAR RECEIVING ANTENNA (left) partially surrounded by ground plane structure. At right, transmitter and triangular antenna; center, radar power plant.*

During the Pacific tests, any modifications or fixes will be carried out at White Sands or Point Mugu instead of at the atoll. The reasoning behind this move is aimed at keeping the personnel at Kwajalein to a minimum.

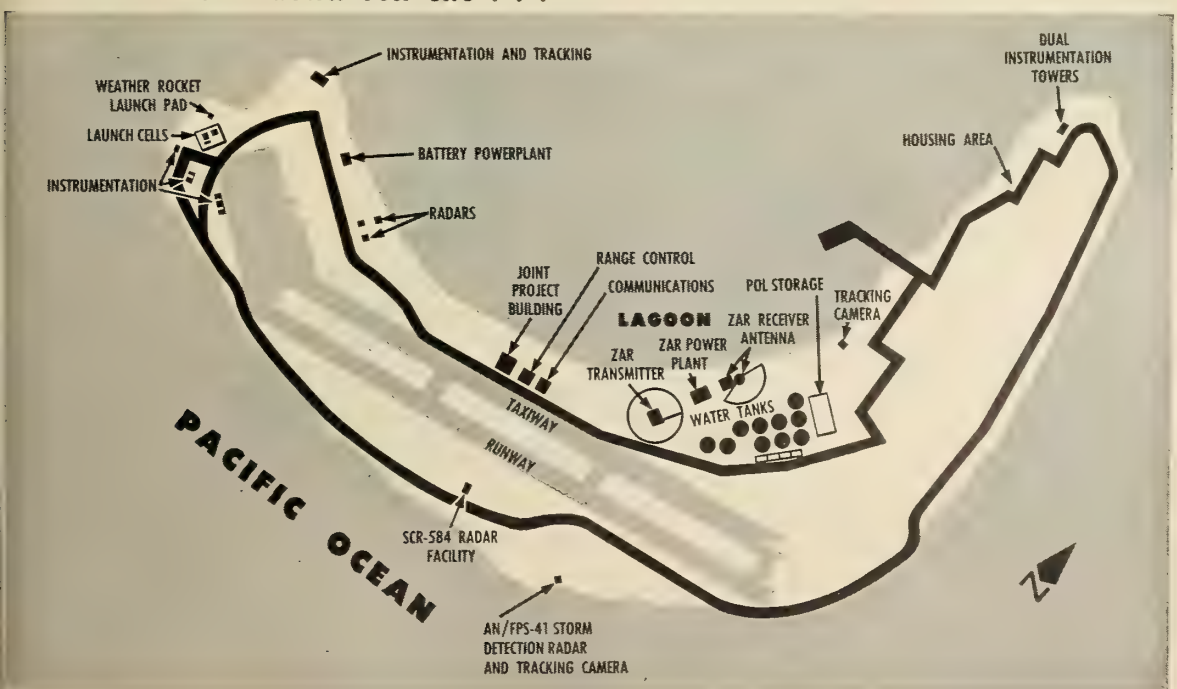
Radar trim will involve B-47 flights, similar to those at White Sands. For Kwajalein tests, an advanced series of *Highball* firings will be undertaken at Roi-Namur. A *Nike-Ajax* booster will be added to the original *Highball* propulsion system to checkout radar and intercept capabilities of the *Zeus* system. Called *Speedball,* this series will reach altitudes in excess of 100 miles. Eventually, *Hercules* missiles will be involved in this aspect of the program.

All of the *Atlas* warheads fired will be part of regular SAC training exercises with ICBM's. The "special" warheads will be designed specifically to confuse *Zeus* or present it with multiple targets and decoys.

The Kwajalein tests are expected to be overwhelming proof of the *Zeus* capability. Various parameters of targets and intercept geometry will be randomized with actual firings and interpolated Blue Room data.

*Zeus* was designed from the beginning to afford a positive defense against the enemy ICBM's of the next 10 years. Accordingly, the Army wants the toughest tests current U.S. missile technology has to offer. ✠

## *KWAJALEIN—Showdown Test Site . . .*



# How Components Makers Met Demands

## Case histories of AiResearch's development of APU and Western Gear's work on system's radar antenna components

*THE PRECISION end performance required of Nike-Zeus imposes severe requirements upon the program's subcontractors.*

*To gain some idea of how these demands are being met,* MISSILES AND ROCKETS *went to manufacturers of two major components in the Nike-Zeus system—The Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, a subcontractor for an important airborne component; and Western Gear Corp., Lynwood, Calif., subcontractor for ground system components.*

*Their experiences, outlined in the accompanying article, typify those of many Zeus suppliers.*

**by Richard van Osten**

COMPLETELY NEW PROBLEMS faced The Garrett Corp.'s AiResearch Manufacturing Division three years ago when it won the subcontract for the *Nike-Zeus* hydraulic auxiliary power unit (APU).

Similarly unprecedented problems were encountered by Western Gear Corp., Lynwood, Calif., when it set about filling its subcontracts for radar antenna components for the *Zeus* system.

In both cases, the critical requirements of the unique anti-ICBM missile system were met or exceeded.

When it began development of its APU, under a Douglas Aircraft sub-contract, AiResearch had the advantage of prior APU work for the *Nike - Hercules.* But the Los Angeles firm found that it was up against problems which couldn't be answered on the basis of previous experience.

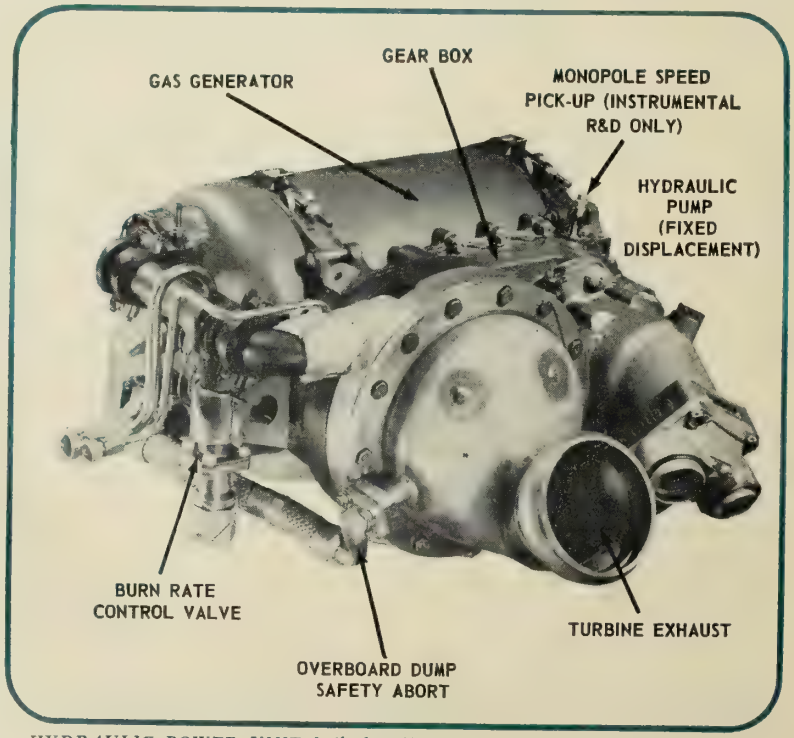
**• Clean propellants** — One was the development of a completely new solid propellant for the APU's gas generator. Most propellant research has centered on the propulsion system, with little attention to specialized, super-clean-burning mixes for APU turbine applications. The system is now using a nitrate-base propellant developed by Olin Mathieson Chemical specifically for the *Zeus APU.*

The propellant did not exist when the program started, but was created to AiResearch specifications by OMC to meet requirements of temperature, burn rate, stability in storage and reliability. The APU operates throughout all *Zeus* flight stages.

**• Pushing the art**—Another problem was design and development of the APU turbine. The turbine now being used in the unit turns at 78,500 rpm, compared to 50,000 rpm in the *Hercules* APU, and has a top speed of approximately 1590 feet per second. The unit is also designed to withstand a 50% overspeed condition. AiResearch claims the 50% operating efficiency makes it one of the most efficient turbines ever developed.

Turbine blades and wheel are integral. Because of the very small clearance between the blades, it was not possible to use a conventional machine cutting method. AiResearch has used several approaches, but the current approach, electrical-type metal removal, is the Elox process with Anodcut as an alternate. So far, the results have been very good despite close spacing of the thin blades and the 2000°F impinging gases.

The APU drives a Vickers pump, but other pumps produced by the Kellog Division of American Brake Shoe and N.Y. Air Brake will be evaluated. Additional propellant evaluation is anticipated also on a Rocketdyne solid mix developed at its McGregor, Tex., facility.




*HYDRAULIC POWER UNIT built by AiResearch for Zeus includes gas generator assembly (in rear), turbine exhaust (front center), pump (lower right).*

The APU has a torque-matching system based upon the high-performance axial turbine's characteristic sloping torque performance curve, where stall torque is greater than rated speed torque and varies between these two points for a constant input gas hp. If a turbine is operating at design speed and load torque, and the load torque is increased, turbine speed will reduce to the point where a new equilibrium condition is established with the higher torque available at the reduced speed.

These parameters may be replaced with pump pressure vs. pump flow, because capacity of a fixed displacement hydraulic pump is directly proportional to turbine speed and the torque required to drive the pump is directly proportional to pump discharge pressure.

In the *Zeus* APU, the design point in gallons per minute (gpm) corresponds to a turbine speed of 78,500 rpm at a pump volumetric efficiency of 96%, and turbine torque at that point corresponds to a pump differential pressure of 3000+ psi. Pump discharge goes directly to an accumulator having an air precharge pressure of 2200±100 psig prior to system start. Accumulator output is directed to the missile system through a regulator valve which maintains missile system pressure between 2700-3200 psig.

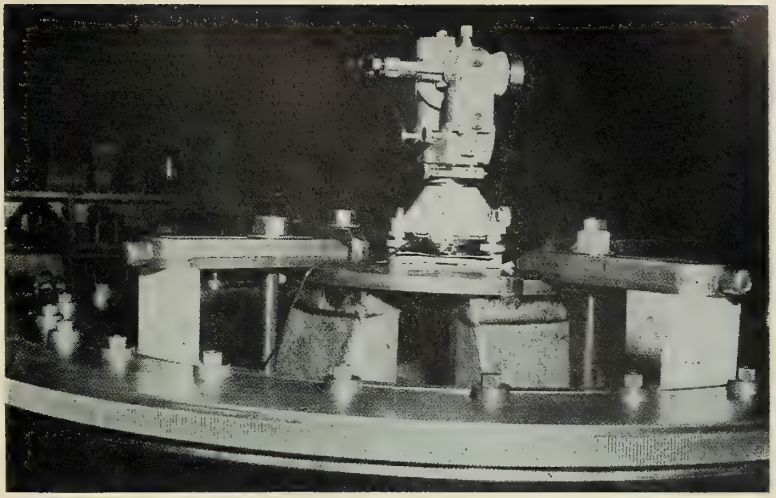
If missile flow demand drops to servo system leakage only, momentary excess output from the pump is prevented from damaging the system by use of a hydraulic relief valve with a cracking pressure of 4000+psi. Bypass flow is returned to the low-pressure reservoir.

The high-pressure accumulator is specifically designed and sized to match turbine and pump characteristics and compensate for turbine system inertia.

The low-pressue hydraulic (bootstrap) reservoir has sufficient oil capacity to fully charge the high-pressure accumulator to meet maximum missile surge requirements. It also provides adequate heat sink capacity to limit fluid operating temperature to 200°F at the end of the operating cycle. A differential area piston in the reservoir provides proper inlet pressure to the hydraulic pump.

Variations in gas generator output are most significant in the *Zeus* APU and must be compensated to make the system workable. To handle this problem, a burn rate control is incorporated to enable adequate matching of input and output torques.

The burn rate control uses basic characteristics of a solid-propellant gas generator. Specifically, if combustion pressure is increased, burning rate will increase and increase the flow rate.



*WILD T-3 THEODOLITE mounted on hobber table was used by Western Gear to check index accuracy of the precision gear used on a Zeus radar antenna.*

• **Challenge to Western**—Western Gear Corp. is subcontractor to both Goodyear and Continental Can for radar antenna components. The company supplies components for the *Zeus* Decoy Discrimination Radar (DDR) and Acquisition Radar (AR) to Goodyear and Target Track Radar (TTR) components to Continental Can.

An extremely critical component in these three antenna systems is the azimuth bearing assembly which carries loads and stresses between the rotating and pedestal sections of the antennas. The bearing is identical in both DDR and TTR antennas.

The bearing assembly consists of a bearing subassembly and a ring gear for antenna position data pickoff. Overall diameter of the assembly is approximately 56 in. Inside diameter of the bearing's outer race is 45 in. The ring gear on the assembly's perimeter has 1344 teeth.

Specifications called for accuracies on the order of 3.4 sec. of arc in angular accuracy between any one gear tooth to any other tooth on the ring.

Other requirements demanded that bearing race radial clearances not exceed 0.0002 in. Overall dimensional tolerances across the assembly's diameter were limited to a very few ten-thousandths of an inch. Specifications required also that the bearing's inner race be capable of being turned over without disturbing tolerances. This minimizes field maintenance problems in bearing replacement.

When Bell Telephone Laboratories first set forth overall requirements for the systems and components, BTL was not certain the needs could be met. Neither was Western Gear, but it was willing to try.

• **Exotic gear checkout**—After deciding the job could be done with existing equipment, the company was faced with the problem of how to prove it had met specifications. In searching for proof techniques, it was determined that an adaptation of methods used by machine tool manufacturers could be used.

This required construction of an optical metrology laboratory equipped with instrumentation rarely, if ever, found in gear inspection techniques. The laboratory also required strict environmental controls and has been designed to hold temperatures to within 1°F.

The critical azimuth bearing assembly is temperature-soaked in the laboratory prior to inspection. Then an instrumentation combination of a Wild T-3 theodolite and Leitz autocollimating equipment is used to determine if the assembly meets specifications. There has been little difficulty with this method, and the company says its rejection rate is almost zero.

A considerable amount of hand assembly is required for the bearing. All rollers in the bearing assembly are "hand-selected" and constantly compared against a master set to determine deviations from the standard and feed in any tolerance corrections required.

The azimuth bearing is one of the most precise units of its type ever developed, a good example of how *Zeus* requirements have pushed the state of the art in a number of technologies. Western Gear's solution is not unique, but it emphasizes that solutions are available to many problems in advanced design and production although they may come from an "outside" source. ⁂

# When the first *line of defense* is *the only line of defense...* *Ultra Reliability* is Crucial!

There is only one anti-ICBM system under advance development in the free world—the U.S. Army's NIKE ZEUS. Once an enemy missile is detected, only minutes remain in which to intercept and destroy it. A Target Intercept Computer developed and produced by Remington Rand Univac solves launching time and predicts the time and point of intercept. At the precise moment, T.I.C. commands the firing of the NIKE ZEUS missile and issues the necessary steering orders to guide it to the target.

The NIKE ZEUS guidance system, produced in cooperation with Bell Telephone Laboratories and the Western Electric Company, demanded—and received—*the fastest, most reliable ground guidance computer yet built with a design goal of 600 operational hours* without component failure. The first of several Target Intercept Computers has been delivered on schedule to the White Sands Missile Range. Experience to date indicates that design requirements have been more than adequately met.

A *permanent twistor memory* and a ferrite core scratch pad memory are vital to reliability, assuring continuous operation until an attacking missile is intercepted and destroyed. Decisions are made in *microseconds*. Built-in error detection circuitry and unique modular construction have resulted in nearly *automatic maintenance*.

Univac's NIKE ZEUS Target Intercept Computer meets new standards of design and capability, and the most crucial test of front line defense—reliability.



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CAPABILITY–INGENUITY–RELIABILITY for Business, Industry and Defense at **REMINGTON RAND UNIVAC**

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*CONSTRUCTION of Zeus receiver enclosure and transmitter at Kwajalein Atoll.*

NIKE-ZEUS

# Bases Would be Many and Sprawling

## *Site on Kwajalein will be operational prototype if production begins now; 'brick and mortar' takes 16 months*

DEPLOYMENT OF *NIKE-ZEUS* would involve a lot of real estate.

The system is huge.

"If you think the bullet is big," says one program engineer, "wait'll you see the gun."

Each defense center with its numerous separate missile-launching batteries would be situated on vast tracts of land. Studies show a typical battery of 24 underground *Zeuses* encompassing up to 125 acres—enough room for three Pentagon buildings and plenty of parking space. A comparable stretch of land would be needed to accommodate the giant acquisition radar, transmitter and power plant of a defense center.

Herein lies a problem. Many batteries designed to protect cities presumably would be located in heavily populated areas. Some skeptics believe it may take a year or more just to acquire some of the land.

But the Army's Corps of Engineers, which would run the construction program, feels more optimistic. The Corps believes that once given a go-ahead they can get the land and complete the "brick and mortar" phase of construction—all within 16 months.

The Corps, however, also is realistic. To avoid lengthy condemnation proceedings, officials are looking over available government-owned land. It may be practical in some areas to utilize existing *Nike-Hercules* sites, or to "satellite" batteries around military installations.

To defend Washington, for example, Army's Ft. Meade, Md., could be used as a base for logistic support and for housing personnel. Perhaps a defense center or some of the batteries could be built on the fort's grounds, thus holding down the amount of new land to be acquired.

• **Changing plans**—Today, plans for deploying *Zeus* are still fluctuating rather widely. They are subject to the many variables being pumped through computers, in search of answers to how much money will buy how much protection. All of these plans are classified. And, because it will be possible to set up *Zeus* in a variety of combinations—with one or many batteries operating off a single defense center—officials are reluctant to give cost estimates on even a single basic unit.

One battery, admits one official, probably will cost "quite a bit more" than a soft *Atlas* base, which bears a $40-million-to-$50-million pricetag.

Perhaps a better guide is the R&D installation now approaching 60% completion on Kwajalein Atoll. This facility—including a complete defense center and a battery of four missiles—is expected to cost $75 million. (However, this figure is inflated by an overseas construction cost index of 2.00 to 3.00, which would bring the cost in stateside dollars to $52.5-60 million.)

Should *Zeus* be committed to production now, the Kwajalein installation would become the prototype for tactical units. Base design—drawn from experience in building R&D installations—already is well advanced, so that the Corps can begin construction whenever it is asked.

• **Simple design**—No great base construction problems are foreseen now—since most of the structures are fairly straightforward in design. The missile, moreover, is solid-fueled, eliminating the intricate fueling systems which created so many headaches in the building of ICBM bases.

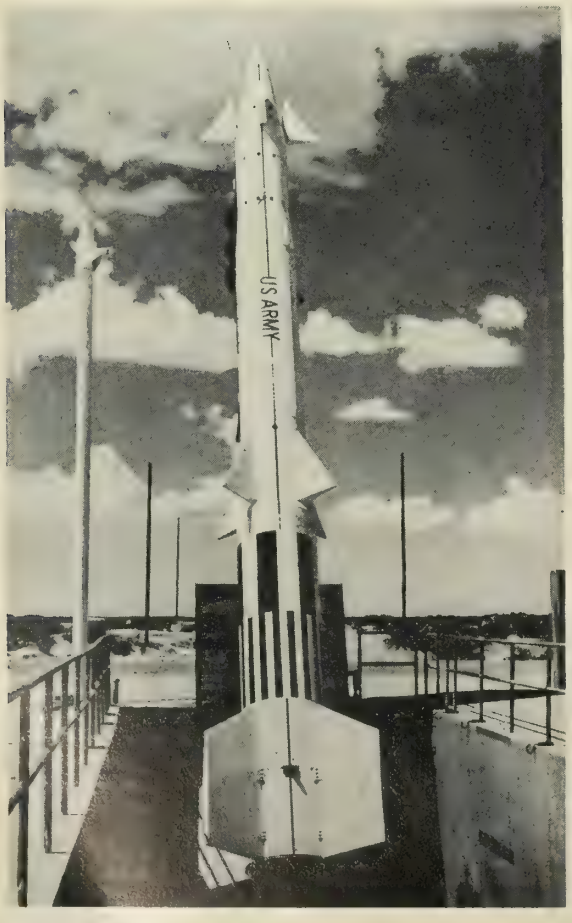
One difficulty lies in providing stable foundations for the huge radars, which impose rather impressive dynamic loads. Care has been taken to design away from harmonic effects and those caused by natural vibrations of the earth.

Safety has been another consideration. During the R&D program some launch facilities were made "over-safe," the Corps has found, simply because there was no previous experience in handling a bird with *Zeus*' high-thrust booster.

The first R&D launcher was an open reinforced concrete structure about 40 ft. deep that allowed exhaust gases to



*FIRST piece of Zeus operational equipment to be installed on Kwajalein. (Atop ZAR Trans. Bldg.) GAC employees in foreground and Capt. Kleis, the ARGMA PFO exec., in background.*




*EARLY R&D launcher at White Sands Proving Ground was used in most Zeus development firings. Operational launcher will be vertical cell type, for underground firing.*

escape unconfined after striking a reinforced concrete deflector. Subsequently, a "cell" type launcher was designed and built which provided for adjusting the degree of exhaust gas confinement.

This is a prototype which Burns & Roe Inc., A&E for facility design, says will lead to the ultimate development of an underground launcher. At White Sands Missile Range there is an underground launch control building which is designed to protect personnel and equipment from an accidental explosion of the missile. The safety factor accounts for the 125 acres needed for the batteries. Moreover, the Corps believes it will have to either get an easement for another 115 acres around each battery or build revetments to protect nearby populated areas.

Thought is being given to hardening the batteries. Missiles would be serviced via tunnels leading from the control buildings which house utilities, instrumentation, data transmission and equipment for remotely controlled warm-up and firing of the missiles.

It is estimated that about 500 tons of air conditioning will be needed for an acquisition site to control the environment of high-powered electronic gear. Design of the defense centers, as well as the batteries, called for solution of several unique problems—including special shielding of electronic equipment and personnel from spurious high-intensity RF energy. The inflatable radomes require a highly redundant pressurization system.

• **Fast reliability** — Basic power sources also are critical. Specs call for a reliability factor of only two 10-sec. interruptions per year. The Corps is planning to insure continuous power with a site-generated steam turbine equipped with a steam accumulator. This will maintain the system until a fast-fired spare turbine can be turned on.

Studies have been made of the practicality of using nuclear power. But only for remote areas outside the continental U.S.

R&D for base construction is being supervised at Redstone Arsenal by Col. Cecil Fuller, deputy chief of the Mobile District Corps of Engineers. Should there be a production go-ahead, base construction would be contracted through the various Corps districts covering the country—in much the same way ICBM and antiaircraft missile base contruction is handled.

Even in the event a full-scale deployment of scores of *Zeus* units is ordered, the Corps does not see any great burden being thrown upon it or the nation's construction industry. As one official puts it:

"If we get construction money for *Zeus*, we will get less for something else. Our worry is not getting it." ⁂

# Management Is All Ready to Roll

***Army-industry team has been geared up for a year to go into mass production; elaborate planning involving hundreds of organizations calls for outlay of $5 million or more per day, if order comes for production program; leaders believe that basic theory of Zeus was well proven in Ajax and Hercules efforts***

**by Frank G. McGuire**

THE ARMY-INDUSTRY TEAM guiding the development of *Nike-Zeus* is already highly organized to enter the A-ICBM into a mass production cycle.

It has been ready to go for a year.

During this period an enormous amount of study has been put into refining the means of bringing forth an operational *Zeus*—in all its complexity—in the shortest possible time. So that now, Brig. Gen. John G. Zierdt, chief of the Army Rocket and Guided Missile Agency, says production procedures and channels are "completely established."

Tooling up is expected to take about one year. But, for all its size, no requirement is seen for additional factory space. Neither will there be a production "line" as such for the system—only for components.

S. C. Donnelly, Western Electric *Zeus* project manager for production, has been organizing a production program since 1959 under a $19.9-million planning contract.

Donnelly has a team of about 1000 engineers at Western Electric's Burlington, N.C., works. They have been staying abreast of developmental changes during the R&D cycle to identify areas that will need attention during production. Their detailed plans cover production value analysis, reliability, quality assurance and design work on tools and facilities.

Moreover, they started to develop production equipment last year under a new $22-million contract. This included the design of pilot lines for the mass production of such items as high-reliability transistors, and other electronic parts—items which will be in demand even if *Zeus* is not funded for production.

• **$5 million daily**—Because of this advance work, Western Electric feels it is "in a good position to go into production now." As one company official put it:

"We've got a head start on the tougher nuts of bringing costs down."

Some idea of the magnitude of Donnelly's problems of moving into mass production can be gained by comparing the change in spending that would result.

Under the R&D program, the countrywide *Zeus* effort is spending an average rate of about $1 million a day. Under a production program, of any size, spending would increase to more than $5 million a day. Moreover, it is not only the amount of spending that is tremendous, but the size and complexity of the *Zeus* subsystems themselves.

The huge radars can not be assembled, tested and shipped; they must be assembled and tested at their deployment sites. The work of thousands of contractors, 14 government laboratories, and dozens of agencies cutting across DOD and the AEC must be coordinated into a production line not unlike that which has produced *Atlas* and *Polaris*.

In addition there are the multiple headaches of coordinating site construction schedules, tieing in the system with the North American Defense Command and solving the strategic questions involved in base deployment.

However, Western Electric officials regard *Zeus* in a broad sense as a natural successor to the *Nike-Ajax* and *Nike-Hercules* systems which they successfully produced.

• **Ajax was proof**—"The design concept is not based on any new theories that have never been tried before," one official said. "We are simply dealing with a longer range, and a smaller target moving at higher speed. The basic theory of *Zeus* was proven in *Ajax*."

Western Electric produced both *Ajax* and *Hercules* on a concurrent basis with their R&D programs.

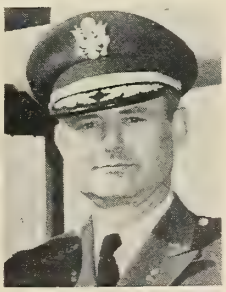
With Hercules, the Army awarded Western Electric a prototype contract more than a year before the R&D models were completed. With *Ajax*, the first production model came off the pro-



ZIERDT



DONNELLY



CRANE

*MANAGEMENT TEAM is headed by Brig. Gen. John G. Zierdt, ARGMA commander. S. C. Donnelly is Zeus project manager for Western Electric. Lt. Col. Glenn Crane, "Mr. Zeus," is ARGMA project director. Primary tool in management procedure is meeting of principal contractors every 4-6 weeks to iron out problems and knock heads together. Since program is countrywide, meetings are held in various regions. January get-together in Los Angeles included visit to Zeus facility at Pt. Mugu and to Douglas plant.*

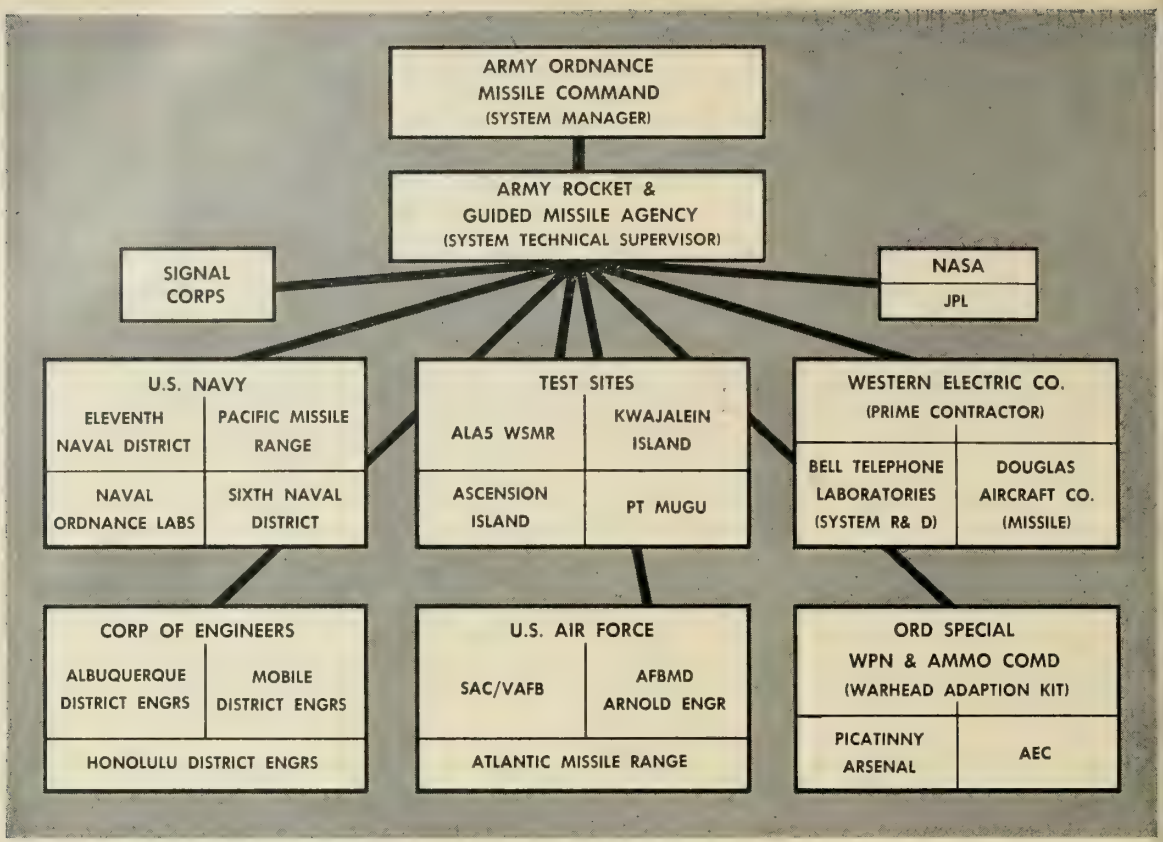



*TABLE SHOWS AGENCIES PARTICIPATING in the Nike-Zeus program.*

duction line only six months after the first prototype.

Western Electric and the Army believe in moving as quickly as R&D indicates production is feasible. Says Zierdt:

"There is a point at which the R&D phases of a weapon system reach a point of leveling off in their improvement of a system, and then it becomes mandatory to go into production or lose vital time."

Feasibility studies on *Zeus* began early in 1955. They were completed in 1956. The initial R&D contract was awarded late the same year and work actually began in early 1957. Both the Army and its industry team have been ready to begin production since late 1959.

No production team has been named in fact, but the general presumption has been that the present team headed by Western Electric (see page 54) would be selected.

Given a go-ahead, Western Electric would center its production control at Burlington.

The government-owned Burlington shops are the second largest of Western's North Carolina plants. Its 700,000 square feet of manufacturing space cover much of the former Tarheel Ordnance Plant.

Western moved into Burlington in 1946. Since then it has used the shops there for the assembly of *Ajax* and *Hercules* as well as ship-based gun directors and antennas. Presently, it is producing components for *Terrier* and *Titan* as well as advanced kits for converting *Hercules* to improved models.

The company-owned Winston-Salem works is the main Western Electric plant in North Carolina. It covers 1.5-million sq. ft. It has 7200 employes producing electronic components, while Western's 280,000 square foot plant at Greensboro has 1600 employes.

Conceivably, failure to obtain a production contract in the next few months might cause some layoffs among the Burlington plant's 4100 employes. It also would affect its 4000 suppliers. The end of 1960 saw the completion of the *Hercules* production run with the exception of the conversion kits.

• **Production planning**—In effect, during the past year, Western Electric has been putting together a series of master plans to roll *Zeus* batteries out at any rate desired by the Army.

The studies have been numerous and detailed. They have included:

–Lead time.

–Flow of equipment from second tier subs to tactical sites.

–Type of documentation necessary to support maintenance.

–GFE (for standardization, availability, etc.)

–Determination of standard production equipment necessary.

–Quality assurance program.

–Transportation. Special demands (expanded to include deployment and installation schedules.)

–Reliability in production.

–Possibility of "breakout" of items for competitive procurement from subs other than R&D companies. (A time phase schedule is being worked out for spare parts procurements and maintenance.)

–Production facility requirements.

–Missile motor cases production.

–Automated transistor production.

–Design of stable platform production.

–Development and inspection techniques for producing the missiles' ablative cover.

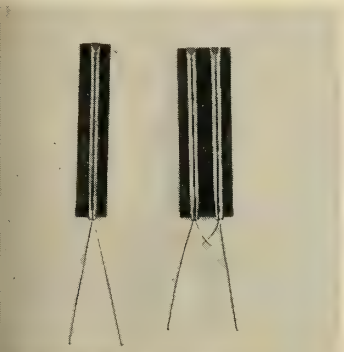
• **Logistic support**—The great problems of logistic support of a program of any magnitude has been given active

*(Continued on page 54)*

# licrodot Acquires licro-Test

s Angeles — Microdot Inc. has en-ed the field of strain measurement vices through the acquisition of cro-Test, Inc. of Santa Monica, Cali-nia. Through this move, Microdot l manufacture and market the only ldable strain gage in the U.S. — a de-e that is capable of continuous opera-n at 800°F and dynamic test to 00°F.

The weldable strain gage, used exten-ely in missile, space, and atomic proj-s, will be integrated with Microdot's sting pressure, force, and acceleration easurement capabilities.



**eldable strain gages, one-piece, etched re filaments in swaged stainless steel bes, are suitable for use from cryogenic elevated temperatures. Photo shows ical gages in actual size.**

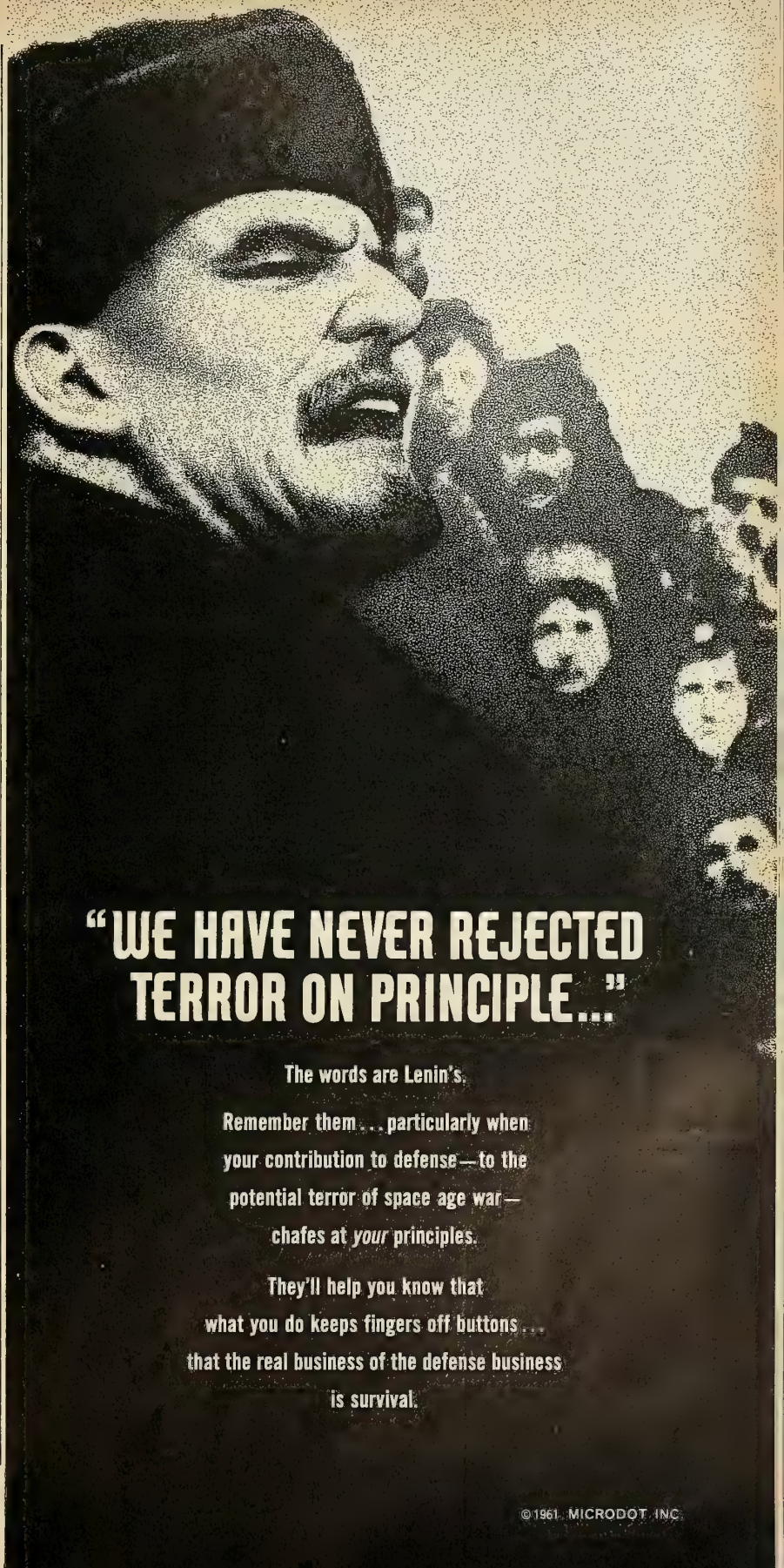
The Micro-Test acquisition is in line h other current moves by Microdot enhance and broaden the company's trumentation capabilities. Other cro-Test products to be offered by crodot include: temperature sensors 60 and 120 ohm resistances that are npletely insensitive to strain, and her-tically sealed load cells with adjust-e temperature sensitivity offered in ges of from 5,000 to 50,000 pounds both compression and tension-mpression.

Microdot sees great potential for the plication of these new devices wher-r physical phenomena can be meas-d and controlled. The weldable strain ge is already being used in atomic ctors, the exterior of submarines, in-e chemical vats, on pilings sunk into St. Lawrence Seaway, and a wide iety of airborne defense projects.

**ICRODOT INC.**

220 Pasadena Ave.
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(Continued from p. 52)

consideration during the R&D phase.

Handling of the more than 100,000 spare parts will be done with high-speed communications to supply depots. While special Composite Support Units comprised of Ordnance, Engineers and Signal Corps personnel will handle maintenance.

Training of cadres for operational units is under way.

The Army and industry say they are ready—all they need is the word from the White House. ⌗

## Nike-Zeus R&D Contractors

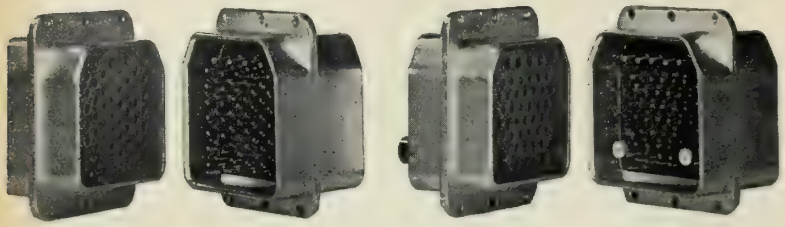
Prime—Western Electric Co.

***Principal subcontractors and area of effort****

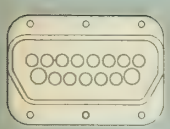
- **Allis-Chalmers Mfg. Co.**—Target track antenna
- **Air Products, Inc.**—Refrigerator for Maser
- **Armstrong Cork Co.**—Acquisition Radar Dielectric
- **Avco-Everett Research Laboratory**—Optical Discrimination
- **Bell Telephone Laboratories, Inc.**—System Design
- **Bomarc Laboratories, Inc.**—High Power Duplexer
- **Burns and Roe, Inc.**—Facility Design
- **Continental Can Co., Inc.**—Tracking Antenna Mounts
- **Continental Electronics Mfg. Co.**—Acquisition Radar Transmitter
- **Douglas Aircraft Co., Inc.**—Missile, Booster, Missile-Handling and ***Test Equipment***
- **Doehler-Jarvis**—Wave Guides
- **Dow Chemical Co.**—Acquisition Radar Dielectric
- **Eagle-Picher Co.**—Battery packs
- **F.X.R., Inc.**—Rotary Joints
- **Goodyear Aircraft Corp.**—Acquisition Radar Antenna
- **I.T.E. Circuit Breaker Co.**—Rotary Joints
- **Kaydon Engr. Corp.**—Bearing Assemblies
- **Lear, Inc.**—Stable Platform
- **Arthur D. Little**—Refrigeration System
- **Messinger Bearing Inc.**—Radial Bearing
- **Minneapolis-Honeywell Regulator Co.**—Accelerometers
- **Narmco Mfg. Co.**—Target Track Antenna
- **Remington Rand Univac**—Computers
- **Sperry Gyroscope**—Target Track Radar Transmitter
- **Steel Products Eng. Co.**—Missile Track Radar Antenna
- **Stromberg-Carlson Co.**—Test Equipment
- **Texas Instruments, Inc.**—Tactical Displays
- **Thiokol Chemical Corp.**—Booster
- **Transfilm-Caravel Inc.**—Motion Pictures
- **Vickers Inc. Div. of Sperry Rand Corp.**—Target Track Antenna, missile APU's
- **Waterman Products Co.**—Oscilloscopes
- **Western Gear Corp.**—Gear Reduction Unit, Drive Gear
- **Westinghouse Electric**—Hydrodynamic Bearing
- **Wheeler Laboratories Inc.**—RF Plumbing

**As listed by Western Electric Co.*

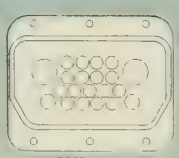

# NEW FROM CEC...RACK AND PANEL CONNECTORS WITH MIL-SPEC CONTACTS



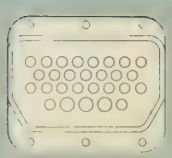
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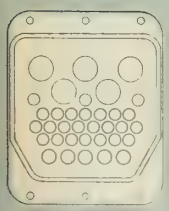
**500L-15:**
**13 size 20 contacts,**
**2 size 16 contacts.**



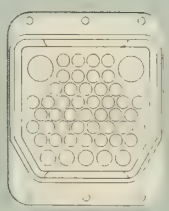
**500L-19:**
**17 size 20 contacts,**
**2 size 16 contacts,**
**2 standard RG58/U coaxial contacts.**



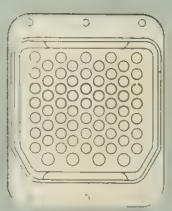
**500L-28:**
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**3 size 16 contacts.**



**500L-30:**
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**5 size 16 contacts,**
**5 standard RG58/U coaxial contacts.**



**500L-48:**
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**500L-63:**
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For more information, write for Bulletin CEC 4006-X7.

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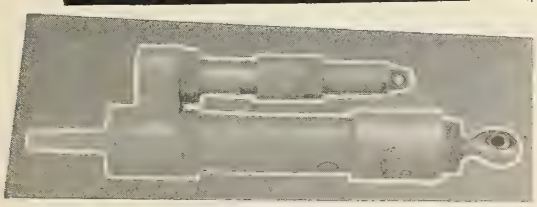
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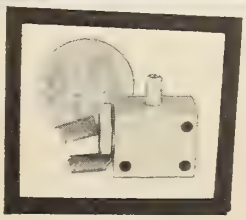
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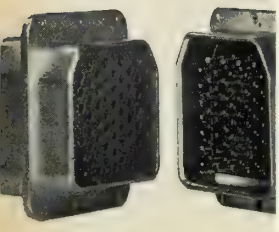
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(Continued from p. 52)

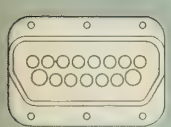
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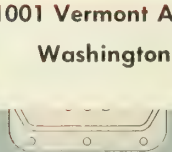
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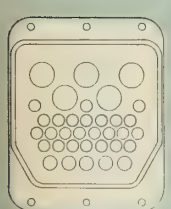
500L-15:
13 size 20 contacts,
2 size 16 contacts.



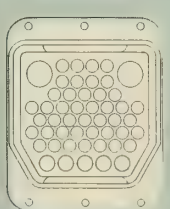
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coaxial contacts.



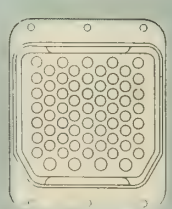
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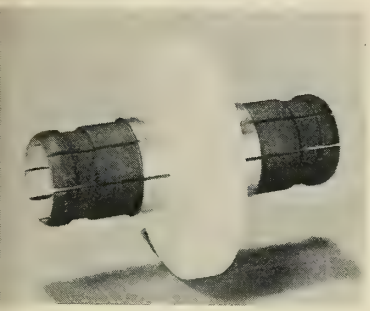
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## Gallium Arsenide Crystals

The Electronic Chemicals Division of Merck & Co., Inc. is manufacturing single crystal gallium arsenide in production quantities. The material is available in both doped and undoped form with carrier concentrations ranging from $1x10^{16}$ carriers per cubic centimeter to degenerate levels. Crystals can be delivered to a doping tolerance of + or – 50%. Dopants employed are zinc, tellurium and tin.

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## Barometric Timer

A type of barometric timer applicable to pilot escape systems, high speed air cargo drop systems and certain missile arming or recovery systems is available from Patterson Moos Research Division of Leesona Corp.

The device, about 4 in. long, less than 1½ in. in diameter and weighing 0.5 lb. is a mechanical clockwork mechanism which provides a fixed time-delay between the time and arming pin is pulled and a pressure cartridge is fired. An internal aneroid block senses altitude and prevents operation outside certain pre-set altitude. An aneroid leak indicator warns of malfunction.

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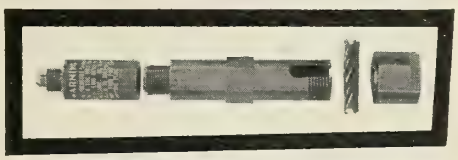
## Zener Reference Element

Hermetically sealed 1N429 silicon zener reference elements for military and civilian land, sea and airborne power supplies will provide voltage stability of ±1% or better over the temperature range from –55°C to –100°C. Manufactured by International Rectifier Corp., the 1N429 has a low 6.2 volt operating voltage (in contrast to the high starting level of gas tube regulators), making it highly suitable for precison instrumentation, computer

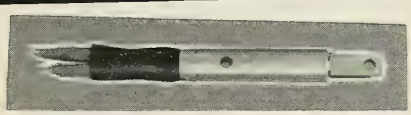

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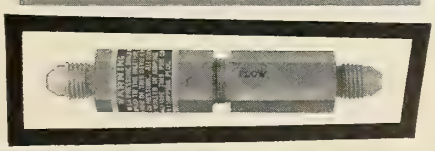
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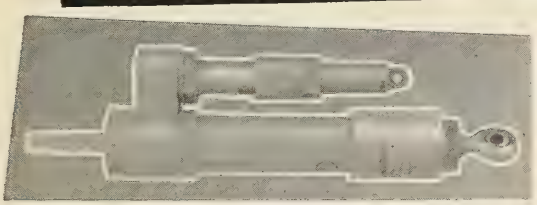
**Cartridge Actuated Cable Cutter, Model No. 133**
for cutting up to ¼" dia. steel cable, wire or tubing. Reusable, with replacement of integrated knife/cartridge.



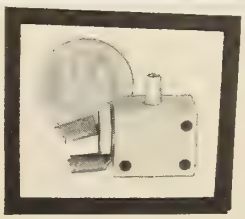
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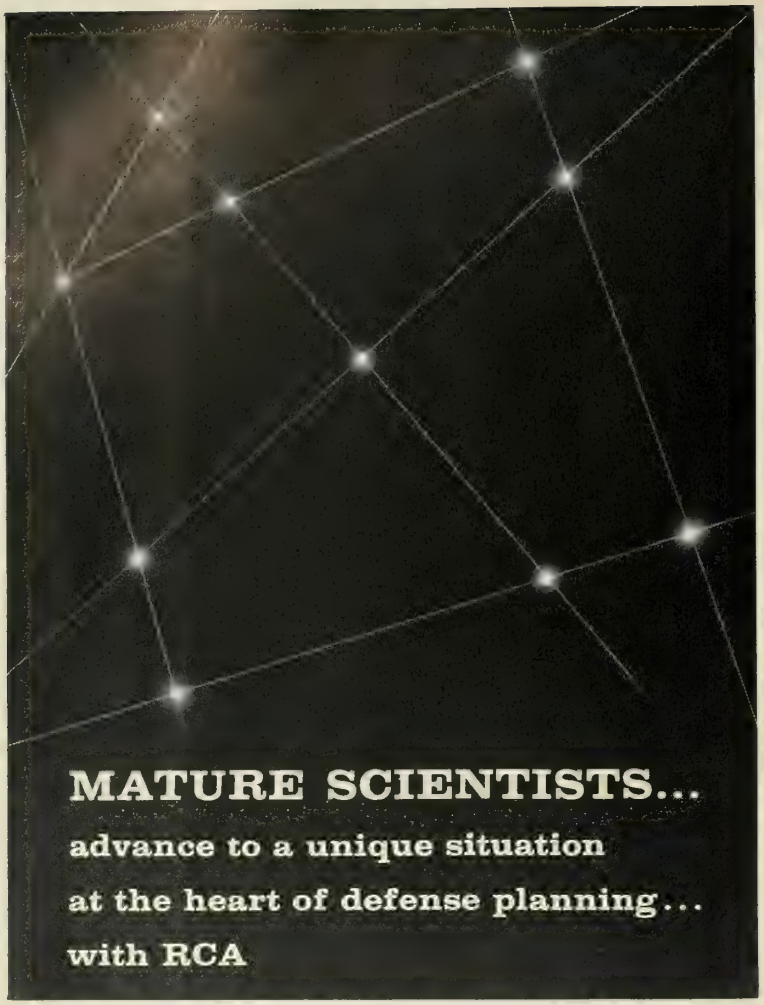
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and other data processing equipment where precise low voltage regulation is required. In addition, any number of 1N429 diodes may be used in series to obtain higher voltage reference levels.

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## Thread Replacement Inserts

Thread replacement without drilling may be accomplished with the Keensert self-locking "Replaceable Sleeve" insert available from Newton Insert Co.

Keenserts are externally threaded right to the top, to provide maximum pull out resistance. Positive mechanical lock against rotation is provided by keys which are tightly fastened in the Keenserts, and are easily pressed into the parent material with a small punch and hammer or a simple installation tool.

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## Metal-Ceramic Resistors

CTS Corporation has added a 42-turn ½ in. square trimmer resistor (Series 170) and a 25-turn rectangular trimmer resistor (Series 180) to its metal-ceramic CeraTrolS line. Extreme reliability and high safety factors at rated wattage are achieved by using a unique CTS-developed metal-ceramic element fired at temperatures exceeding 600°C, resulting in hard surface, low contact resistance element. Both units have infinite resolution, complete resistance range from 100 ohms thru 1 megohm and extreme stability.

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## Film Resistance Cards

Filmohm Corp. is marketing a metal film resistance card, a highly stable microwave attenuator material. The base is a fine weave glass cloth impregnated with high temperature thermosetting resin which meets MIL-P-18177. Resistance material is a thin film of pure metals, approximately 50 millionths of an inch thick, uniformly deposited on one surface of the plastic. A protective coating is provided.

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## Rotary Commutators

Rotary Commutators for analog-digital conversion, telemetry, sampling, scanning, programing, and pulsing are available from Airflyte Electronics. Gold or rhodium plated contacts are firmly embedded in epoxy resin and diamond turned to 4-6 micro-inch stepless finish. Commutating surfaces are engaged by special broom type multiple strand brushes to produce minimum noise and life expectancies in excess of $2 \times 10^7$ cycles at up to 2000 RPM.

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*AN ACHIEVEMENT IN DEFENSE ELECTRONICS*

# HIPAR Proves Effective In Hercules Anti-Missile Test

This new General Electric *High Power Acquisition Radar* (HIPAR) more than triples the detection capability of the U. S. Army's Nike-Hercules System. Produced for Western Electric, Nike-Hercules System Prime Contractor, this General Electric radar provides high resolution target data at long range and high altitudes on bomber and fighter aircraft, air-launched missiles and tactical ballistic missiles. The effectiveness of this Improved System was demonstrated at the White Sands Missile Range on June 3, 1960, with the successful intercept and destruction of a Corporal Missile, and in August and September, 1960, when target Nike-Hercules Missiles were destroyed by their defending counterparts at altitudes to almost 100,000 feet and closing speeds near Mach 7. 176-06

HEAVY MILITARY ELECTRONICS DEPARTMENT
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## industry

**GENERAL ELECTRIC** has established a new operation at Palo Alto, Calif., to centralize its nuclear power design and development activities for specialized applications such as manned and unmanned space vehicles and satellites.

**INTERNATIONAL TELEPHONE & TELEGRAPH** has joined its ITT Laboratories to the ITT Federal Division to form a single operating unit which will be known as ITT Federal Laboratories.

**THOMPSON RAMO WOOLDRIDGE** is moving nearly 200 TRW personnel from offices in the Los Angeles area to Canoga Park headquarters. Among those involved in the move are 120 members of the TRW Computers Company, formerly headquartered in Beverly Hills.

**DOUGLAS AIRCRAFT CO.** has started the first phase of a $2-million modification program at its Sacramento field station in preparation for system and static testing of the *Saturn S-IV* and other space vehicles. Major items in the program include the installation of a liquid hydrogen storage and transfer system and the altering and enlargement of two test stands for cold-flow testing and static firings of the *S-IV*.

**THE MARQUARDT CORP.** Pomona Division has moved into a new 27,500-sq.-ft. engineering building in the same city.

**TENNEY ENGINEERING** has formed a division to design, develop and produce ground and flight support devices.

**W. L. GORE & ASSOCIATES**, manufacturer of Teflon-insulated wire and cable, has completed a move into a new plant near Newark, Del., adjacent to its old plant.

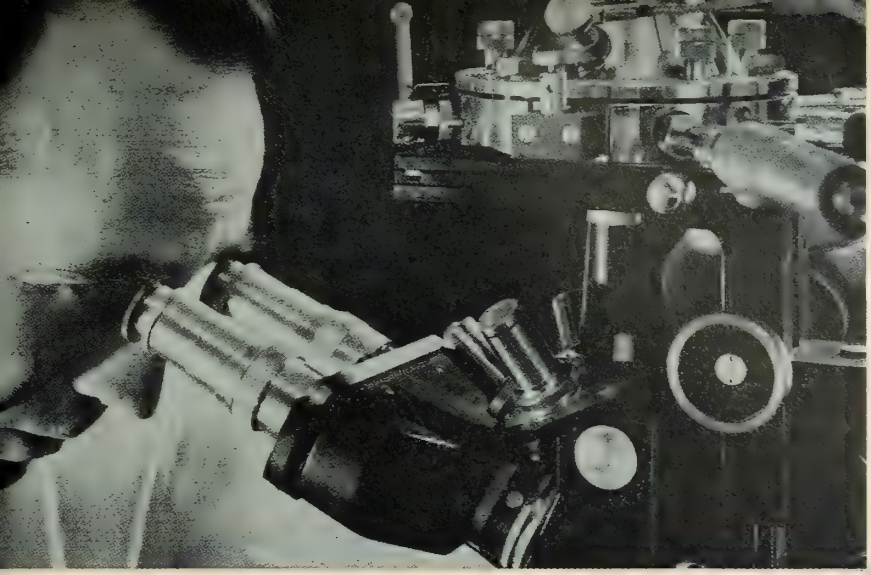
**IBM FEDERAL SYSTEMS DIV.** will complete its new Communications Center at Rockville, Md., near Washington, D.C. on Feb. 1. Research at the 38,000-sq.-ft. center will emphasize improvements in systems design and reliability in both radio spectrum and direct wire communications.

**ILIKON CORP.**, founded by a group of MIT scientists for material research, has opened offices and a research laboratory in the Natick Industrial Centre, Natick, Mass.



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Circle No. 17 on Subscriber Service Card. →





Extremely high temperature material problems encountered on re-entry into earth's atmosphere are studied with the aid of a plasma jet capable of 30,000°F.

Basic effects of elevated temperatures on various materials are viewed and photographed with the hot stage microscope.

# CAPABILITY is spelled

## r-e-s-e-a-r-c-h

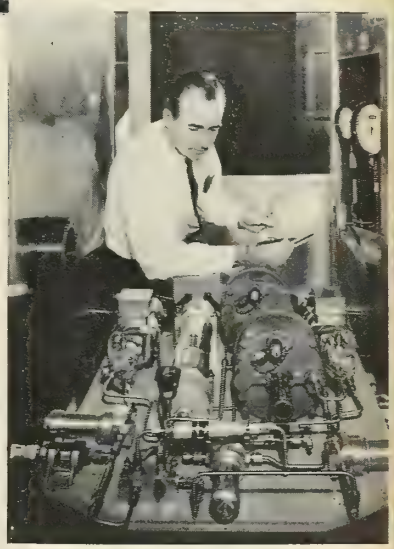
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ew fluid power and hot gas systems for aerospace vehicles still in the idea ages are being developed at Vickers. Techniques for converting basic energy to precisely controlled power are continuously being sought by experienced ams of research specialists utilizing the finest scientific equipment.

Creative application of the sciences of hydrodynamics, aerothermodynamics, at transfer, metallurgy and chemistry have been productively blended with ckers vast experience in the instrumentation and control fields.

The principal effort of Vickers applied research is now concentrated in ree areas: 1. advanced systems and components for attitude controls, secondary rocket nozzle injection and 3. hot gas servo actuation. In addition, ntinuous refinements are being made to the high performance Vickers hy-aulic pumps and motors.

The experienced Vickers Application Engineer in your area will welcome e opportunity to fill you in on additional details. In the meantime, write or ll for Bulletin A-6002.



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Analyses of fluids, propellants and special coolants for electronic equipment is carried out in completely equipped chemistry laboratory.



Analog computer (shown) and solid state Univac digital computer give Vickers the important edge in solving complex engineering problems.

9267

## names in the news

**Homer R. Denius:** President of Radiation Inc., elected chairman of the board. He will retain the presidency. Mr. Denius, one of the founders of the firm in 1950, was formerly vice president and chief engineer of Melpar, Inc.

**Robert E. McDowall:** Vice president of Cohu Electronics, Inc., elected to the board of directors of Exact Engineering & Manufacturing, Inc.

**W. E. Cleator** and **G. Jewett Crites:** Vice president and director of future planning, respectively, elected to the board of directors of Tool Research and Engineering Corp.

**Richard S. Cesaro:** Appointed vice president, corporate planning, research and development at Autometric Corp. Was formerly technical director and scientific consultant to ARPA—Advanced Research Projects Agency, Institute for Defense Analyses-Office of the Secretary of Defense.

**Walter H. Powell:** Vice President of Industrial Relations for International Resistance Co., named vice president of Operations.

**William H. Rous:** Appointed vice president, International Operations, Amphenol-Borg Electronics Corp. He will continue to serve as vice president, marketing.

**Paris H. Stafford:** Chief Engineer for Permanent Filter Corp., promoted to vice president in charge of engineering. Prior to joining the firm in 1952, he served as supervisor of guidance and control equipment in the Autonetics Div. of North American Aviation.

**Elwood Roger Zeek:** Joins The Diehl Manufacturing Co. as vice president in charge of research and engineering. Was formerly associated with the Walter Kidde & Co., Inc.

**Henry Feldmann:** A founder and board chairman of FXR, Inc., resumes the presidency of the company, succeeding **Tore N. Anderson,** who has resigned.

**Ralph F. Gow:** Elected president of Norton Co. **Milton P. Higgins,** president since 1946, moved up to chairman of the board, succeeding **George N. Jeppson,** who now has the title of honorary chairman.

**Warren W. White:** Appointed to the newly created post of assistant director of engineering for Robertshaw-Fulton's Aeronautical and Instrument Division. Was formerly supervisor of instruments products engineering.

**General Nathan F. Twining** (USAF, Ret.), former chairman of the Joint Chiefs of Staff, last week received the National Security Industrial Assn. James Forrestal Memorial Award. The award is presented annually to the man who, in the opinion of NSIA members, has "contributed most to cooperation between industry and the Defense Department."

**Harry L. Hildebrand:** Former manager of process and design engineering for Taylor Fibre's plants at Norristown and LaVerne, Calif., joins Dytronics, Inc. as general manager.

**Dr. Harold V. Hance:** Joins the Systems Research Center of Lockheed Electronics Co. as both associate director of the center and a senior scientist. Was formerly senior scientist in the Research and Development Laboratories at Hughes Aircraft.

**David Fales III:** Named chief engineer for Gabriel Electronics, Division of The Gabriel Co. Was formerly manager of electronic product sales and staff engineer for The Martin Co., Baltimore.

**Dr. Curtis E. Miller:** Appointed director of the Medical Sciences Dept. of Dynamic Science Corp., a subsidiary of Marshall Industries.




KARL LAMBRECHT AT THE MINES

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## Missile/Space Week

(Continued from page 14)

10-year development of titanium technology. Current problems include improving the physical characteristics, reducing the cost and removing the toxicity hazard.

### New Mercury Flight Plan

The *Mercury Redstone-2* Chimpanzee-bearing capsule test, scheduled for this week, will follow a lower, flatter trajectory than last month's successful *MR-1* flight.

Peak altitude will be 115 statute miles instead of 130, while the capsule is aimed at a spot in the Atlantic 290 miles downrange from Cape Canaveral, instead of 235 miles. The trajectory was lowered for range safety considerations and to reduce re-entry g loads from 12½ to about 11.

*MR-2* will be the first flight in the *Mercury* series to fully test the Abort Sensing Instrumentation System (ASIS), which orders firing of the escape rockets in case it detects anything going wrong. In previous flights the system has operated on open loop—that is, the signals were given but the escape rockets were set to fire only on command from the ground.

The flight will also mark the first flight test of the life support system. It will also have a psychomotor test to determine whether the chimpanzee can perform functions it can carry out on the ground and whether launch, weightlessness and re-entry have any physical or psychological effects on the animal.

A movie camera will photograph the animal during flight for observation of the chimp's state of awareness.

The psychomotor test is a game involving three colored lights, two levers and a faint electric shock applied to the animal's foot if he does not obey the rules. The six chimpanzees have become quite proficient in the game during training at Holloman AFB, N. M.

The chimpanzee and a backup animal, which will also be wired with telemetry equipment and kept on the ground, will be chosen from a group of six at the Cape 24 hours before the launch. The launched animal will be in a special couch with oxygen lines to the regular life support system.

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Missile/Space Conference

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*military applications in space*
*commercial applications in space*
*market outlook / new developments*

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# First Polaris Sub Returns

THE OFFICERS of the nuclear-powered submarine George Washington first of the *Polaris* fleet, are giving high marks to her maze of equipment for its performance during her first deployment on station.

Cmdr. James B. Osborn, skipper of the George Washington, said after returning from the cruise Jan. 21:

"My crew and my ship performed above my expectations. The missile system was better than even we hoped it would be. And be don't pass out pretty good marks for nothing."

The George Washington tied up beside her tender, the Proteus, nearly 67 days after deploying from the Naval Weapons Annex near Charleston, S.C., on Nov. 15.

She had operated submerged and "buttoned up" for approximately 66 days and 12 hours—a record. The old record, held by the nuclear-powered sub Seawolf, was 60 days, 10 hours, 23 min.

The George Washington will be completely serviced by the Proteus before deploying again with a fresh crew. Then the Proteus will sail for her permanent advanced base at Holy Loch in the Clyde Estuary, Scotland.

The Navy directed the Proteus to take on her first servicing job at New London to make certain that her facilities are adequate and to provide back-up equipment if necessary.

"You might say we are cutting our teeth on the Gorge Washington," one officer said. ⌗



*COMING UP FOR George Washington and her sister ships is the 30-inch-longer Polaris II (A2) model with its 1500-mile-range. An Aerojet technician stands before a Polaris I (A1) and Polaris II first-stage motor case to show their comparative sizes.*

# In FY 1960

## General Dynamics and Lockheed Led in Awards

GENERAL DYNAMICS CORP. tops the list of 100 companies and 118 subsidiary firms that received the largest dollar volume of military prime contracts during Fiscal Year 1960.

General Dynamics received $1.2 billion of the $15.4 billion of prime contracts totalling $10,000 or more awarded the 100 companies. Lockheed and it subsidiaries ran second with $1.01 billion.

Positions were reversed for the two firms in the list of the top 400 prime commercial contractors that received the largest dollar volume of military prime contracts for experimental, developmental, test and research work.

Lockheed received $666.3 million. General Dynamics received $528 million.

The total new value of all EDTR awards of $10,000 or more increased during FY '60 from $5.2 billion to $5.5 billion.

The first fifteen companies in prime contracts, in addition to General Dynamics and Lockheed, included:

Boeing Airplane Co., third, $1 billion; General Electric Co., fourth, $963.1 million; North American Aviation, Inc., fifth, $907.7 million; The Martin Co., sixth, $596.7 million; United Aircraft Corp., seventh, $517.4 million; American Telephone & Telegraph Co., eighth, $466.8 million; Radio Corp. of America, ninth, $405.8 million; Douglas Aircraft Co., 10th, $404.9 million; Hughes Aircraft Co., 11th, $349.1 million; Raytheon Co., 12th, $323.4 million; Sperry Rand Corp., 13th, $296 million; International Business Machines Corp., 14th, $290 million, and Republic Aviation Corp., 15th., $265.1 million.

The top fifteen firms in EDTR prime contracts, in addition to Lockheed and General Dynamics, included:

North American Aviation, Inc., third, $473.8 million; General Electric Co., fourth, $396.7 million; Western Electric Co., Inc., fifth, $270.3 million; The Martin Co., sixth, $245.8 million; Boeing Airplane Co., seventh, $205.7 million; Aerojet-General Corp., eighth, $182.5 million; Sperry Rand Corp., ninth, $120.1 million; Westinghouse Electric Corp., 10th, $118.4 million; Douglas Aircraft Co., 11th, $100.3 million; Thiokol Chemical Corp., 12th, $99.4 million; Radio Corp. of America, 13th, $92 million; General Motors Corp., 14th, $81.6 million, and Avco Corp., 15th, $80.8 million. ⌗

# Discoverer Communications 'Pinpoint'

## *Philco says high accuracy of communications and control system is responsible for recovery successes in program*

PALO ALTO, CALIF.—Details of the communications and control system for recovery of Air Force *Discoverer* satellite vehicles indicate growing AF confidence in its ability to recover instrument capsules on an almost-routine basis.

Latest information was revealed by Philco Corp.'s Western Development Division, associate prime contractor on the communication and control aspects of *Discoverer,* which said pinpoint accuracy of the network has been responsible for successful recoveries so far.

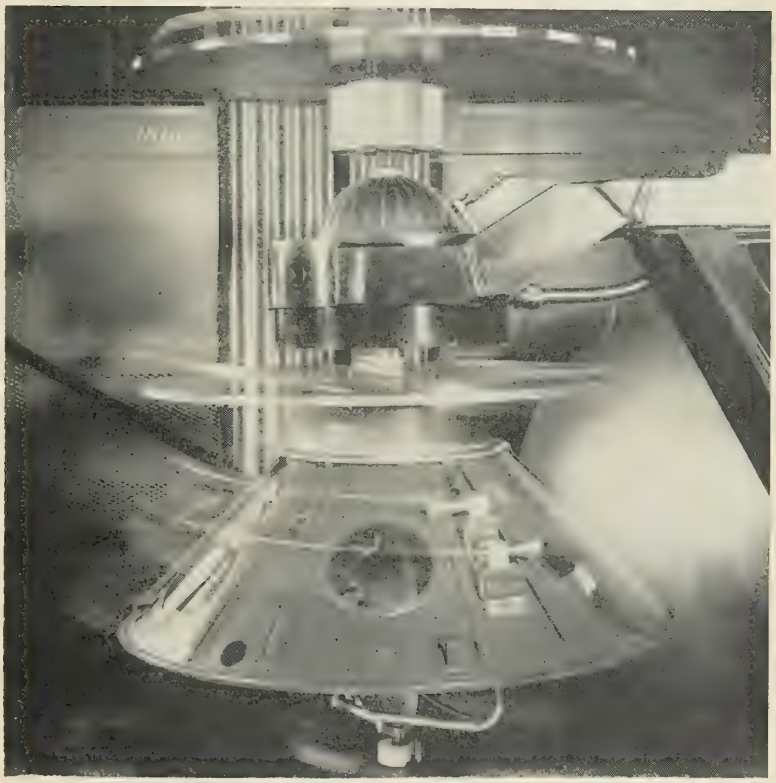
(Almost simultaneously, Lockheed Missiles and Space Division pinpointed axial instability as the cause of earlier recovery failures.)

The entire communication and control portion of the *Discoverer* vehicle is designated Subsystem H, and has four basic functions: to provide tracking data on the satellite and its instrument capsule; to command the vehicle to perform such functions as second-stage ignition, capsule ejection, and other command functions; to collect telemetry data; and to insure that all events are carried out on a common time basis.

• **Equipment** — Four interlocked electronic subsystems make up the complex: a long-range tracking radar to provide azimuth, range and elevation data, including an analog computer to assist in acquisition of the satellite; a command subsystem operating over the radar link; a Doppler telemetric reception subsystem; and a data processing and transmission subsystem.

Satellite-borne equipment includes four sources of rf energy: a vhf cw oscillator for providing a continuous signal for initial acquisition; an S-band pulse-beacon transponder; an S-band beacon in the recovery capsule, energized after capsule ejection; and an FM/FM telemetry transmitter.

Ground equipment consists of a Doppler-receiving unit which picks up the cw oscillator signal for target acquisition via a tri-helix antenna; the VERLORT (very-long-range tracking) radar which triggers the pulse beacon transponder at ranges up to 2500 miles; and the telemetry receiver subsystem.



*AXIAL DEVIATIONS were plotted photographically with this air-bearing test bed, according to Lockheed, thus solving a major re-entry problem in the Discoverer recovery program. Test vehicle is rigidly suspended from bottom of bearing.*

Antennas of all three subsystems are slaved together during operation, usually after the tri-helix antenna has made initial acquisition as the satellite rises over the horizon from the north. The primary ground station is at Kodiak, Alaska.

Human control over the complete operation is administered from the master control console, the focal point of all display and control data. All information received at the ground station is fed into a processing and transmission system, composed of high-speed teletype circuits and other equipment, to keep the AF Satellite Test Center at Sunnyvale, Calif., informed of the satellite's position and status.

About fifty separate telemetering elements make up the system, which Philco says is virtually free of redundant design features but suffers no loss in reliabilty.

• **Discoverer mission** — As spelled out by Philco, the nominal sequence in a *Discoverer* mission is as follows:

Optical tracking utilized at liftoff is switched to radar surveillance immediately upon confirmed radar acquisition above the surrounding ground clutter and transmitter-pulse clutter pattern. The VERLORT radar at Vandenberg AFB is slaved to the optical tracking unit to assure radar acquisition. The destruct radar at VAFB is under separate control of the ground safety officer.

The target is tracked through its

launch phase until the time comes to pass it to the Point Mugu radar center. This center includes a computer for determining time-to-fire of the second stage.

The system computes the situation of the satellite, using the station's angle and ranging information to command second-stage ignition and control burning time. A tracking ship 900 miles downrange transmits performance data to the Satellite Test Center (STC) by way of a single-sideband radio link.

To conserve power, all instrumentation except the cw acquisition transmitter is turned off on the first orbit.

Data computation is centralized at STC, where corrections in planned performance are made, based on actual vehicle performance. The revised data are put on the teletype circuit to all tracking stations, which store the information on an acquisition programer enabling tracking antennas to look at a selected point on the vehicle's orbit where it is expected to rise over the horizon.

In this aspect of the operation, redundancy is utilized to insure acquisition by using the orbital computer of each VERLORT unit as a backup method of predicting the point of expected acquisition.

When the time of expected acquisition nears, the tri-helix antenna array of the Doppler subsystem is trained on the target spot in space. The continuously operating cw oscillator provides the first signal for the ground station, and a refined acquisition data estimate is made. The other two antennas in the ground complex are slaved to the tri-helix antenna, and the VERLORT radar locks onto the vehicle, the electronics of which have since been turned on. ⌗

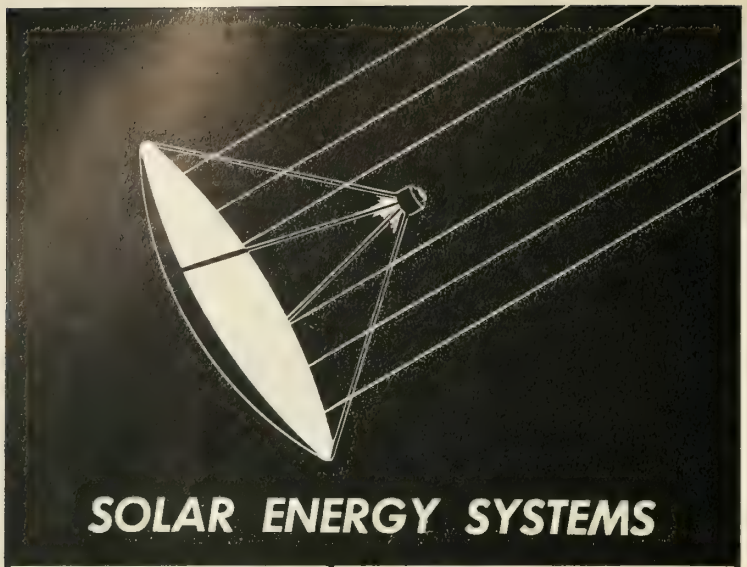
## Tiros II Reduced to IR, Direct Observation

*TIROS II* WEATHER information now is limited to infrared observations and direct readout of cloud-cover photographs while the satellite is in view of ground stations.

A malfunction in the timing clock operation and the wide-angle camera system threatening total power drainage made necessary an indefinite suspension of programing wide-angle photographs on Jan. 18.

A different erratic behavior made it necessary to temporarily suspend programing of the narrow-angle camera system. However, scientists of the National Aeronautics and Space Administration expected programing would be resumed after a system analysis.

*Tiros II*, launched Nov. 23, took 9524 wide-angle photographs that could be usefully interpreted. ⌗

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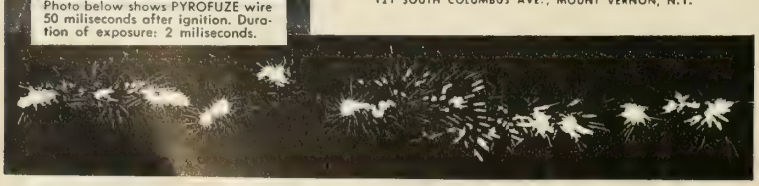
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Photo below shows PYROFUZE wire 50 miliseconds after ignition. Duration of exposure: 2 miliseconds.



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# AT&T Authorized to Use Two Gigacycle Channels by FCC

***Firm may win inclusion in Relay project or it may get launch service for vehicle at cost from NASA***

AMERICAN TELEPHONE & Telegraph Co. has authority to make use of two channels in the gigacycle spectrum for communication satellite experiments this year, but a launch vehicle may not be available until 1962.

The National Aeronautics and Space Administration, meanwhile, is asking for bids by March 6 on Project *Relay*, a program for developing and demonstrating an active repeater communications satellite.

It is possible that the AT&T plan, approved by the Federal Communications Commission, might be accepted as the industry program on Project *Relay*. It is equally possible that NASA might go ahead on a contract with one company and arrange to provide launch service at cost to AT&T for its satellite.

The launch vehicle involved is the *Delta*. Two additional *Deltas* are to be procured for the communications satellite program with part of a requested $24-million supplemental appropriation for the current fiscal year.

The lead time requirement on *Delta* vehicles means that a new one added onto the program cannot be available for mating with the spacecraft at Cape Canaveral before May 1, 1962. However, there are two backup vehicles in the nine to be launched in the present program over the next 18 months. Conceivably, one of these might be available.

• **Reassurance**—NASA spokesmen emphasized that the one-year limit on the license granted to AT&T is merely routine and is subject to routine renewal. Thus, they argued, the license sets no time limit making any haste necessary in negotiating arrangements.

The FCC authorized AT&T to use the 6325-6425 megacycle channel for transmitting to its experimental satellite with 3-kilowatt power and the satellite was authorized to transmit at 5 watts in the 4100-4200 megawatt channel. Both bands were taken from bands already assigned to common carriers. The experiments will include investigations of the feasibility of sharing channels between satellite-ground links and point-to-point earth communications.

### *Relay Satellite Specifications*

| | |
|---|---|
| Weight | 85 lbs. ± 10% |
| Shape | Cylinder leading to truncated cone capped by hemisphere |
| Total length | 50.25 in. |
| Cylinder length | 16.25 in. |
| Max. diameter | 29.0 in. |
| Min. diameter | 10.0 in. |
| Launch vehicle | Delta |
| Transmitter frequency | 400-500 mc |
| Receiver frequency | 2200-2300 mc |
| Power supply | solar cells, batteries |
| Apogee | 2500-3000 naut. mi. |
| Perigee | 600-1400 naut. mi. |
| Orbital inclination | 30°-55° |
| Period | 180 min. |
| Temperature required | 40°-70°F |
| Operating life | One year |
| Radiation package weight | 19 lbs. |
| Radiation package volume | 90 cu. in. |
| Radiation package power need | 6½ watts |

The commission thus rejected the company's application to use the 6425-6925 mc band for the experiments. In a separate order, the FCC also rejected as premature the company's proposal that the 6425-6925 mc band be assigned to satellite relay use on a shared basis with other services. The order was announced on Jan. 19, the last day of the Eisenhower administration.

The FCC reported that the AT&T satellite would cost $250,000 and that launch costs were estimated at $3 million. The cost of the earth station at Holmdel, N.J., was estimated at $106,000. The commission authorized the company to use the channels for experiments involving as many as six satellites.

• **Price tag later**—NASA spokesmen said discussions with AT&T had not even reached the negotiation stage on the price the government will charge the company for launching its satellite. The discussions are continuing on technical details of the AT&T proposal.

It was understood that NASA does not intend to conclude the arrangements with AT&T until it receives an indication of the attitude of the Kennedy Administration and Congress toward former President Eisenhower's order authorizing the agency to make launch facilities available to private industry at cost.

NASA's Goddard Space Flight Center briefed industry on requirements for the Project *Relay* satellite Jan. 24 and 25. The specifications called for use of government-assigned frequencies of 400-500 mc for the satellite transmitter and 2200-2300 mc for the ground station. But the specifications allowed for substitution of other frequencies by the contractor if a good reason were given. This obviously enabled AT&T to substitute the frequencies assigned to it by the FCC.

The FCC authorized AT&T to communicate with experimental stations in the United Kingdom, France and the German Republic. AT&T commented:

"We are pleased with the Commission's decision because we can now firm up our plans for the next step toward a space communications system. We are most anxious to have an active satellite in orbit within a year and will push vigorously toward this. To do so, we have asked the government to supply launching facilities and we have offered to pay the costs."

Earlier this month, AT&T announced that the Bell System showed a profit of $1.244 billion in the 12 months ended last Nov. 30—an all-time record level of profits for one company in one year. The previous high of $1.189 billion was set by General Motors in 1955. ⌗

## Hughes to Build NASA's Surveyor Spacecraft

*SURVEYOR*, a 750-lb. package of television cameras, a drill 18 in. long and sophisticated scientific instruments, will make seven flights leading to soft landings on the moon in the period 1963-66.

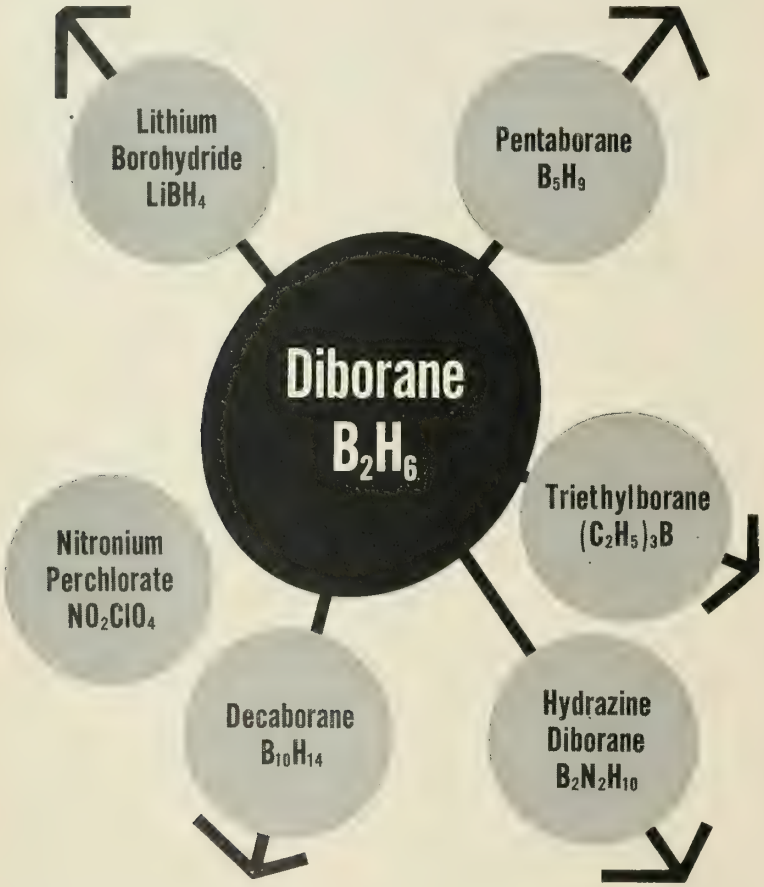
The National Aeronautics and Space Administration is negotiating with Hughes Aircraft Co. for developing and producing the spacecraft, at a cost upwards of $50 million. T. Keith Glennan approved selection of Hughes over three other companies on Jan. 19.

The *Surveyor* spacecraft will weigh about 2500 lbs. when launched into a lunar trajectory by an *Atlas-Centaur* vehicle. Most of the weight will consist of solid propellant for a retro-rocket designed to slow the lunar landing speed to between 5 and 10 mph, a little slower than a manned parachute landing on earth. ⌗




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# contracts

## NASA

**$3,008,000—Packard Bell Electronics Corp's Technical Products Div.,** Los Angeles, for development of an automatic checkout system for the *Saturn* booster.

**$105,000—Chance Vought Astronautics,** Dallas, for orbital launch operation studies investigating technical and economic feasibility of launching space vehicles from an earth orbit.

**$92,000—Douglas Aircraft Co.,** Santa Monica, Calif., for orbital launch operation studies investigating technical and economic feasibility of launching space vehicles from an earth orbit.

## NAVY

**$700,000—Royal Industries, Inc.,** Los Angeles, for atomic reactor control rod actuators to be used on atomic submarines. Subcontract from **Westinghouse Electric Corp.**

**$600,000—Summers Gyroscope Co.,** Santa Monica, for spring-wound gyros for use in the *Bullpup*.

## ARPA

**Atlantic Research Corp.'s Space Vehicles Group,** Pasadena, Calif., for all engineering, fabrication and field services for six firings of the four-stage *Trailblazer II* rocket vehicle. Subcontract from **Massachusetts Institute of Technology, Lincoln Laboratory.** Amount not disclosed.

**Ryan Aeronautical Co.'s Aerolab Development Co.,** Pasadena, has received contracts for seven *Trailblazer I* six-stage rocket vehicles to be used in re-entry vehicle research.

## AIR FORCE

**$3,590,177—Burroughs Corp.,** Detroit, for installation and logistic support of data processing equipment for the *Sage* program.

**$176,000—Republic Aviation Corp.,** for development of extrusion processes for titanium metal.

**$100,000—Boeing Airplane Co.'s Aero-Space Div.,** Seattle, for building rocket engine fuel tanks from spun glass threads.

**$49,454—Electro-Optical Systems, Inc., Solid State Div.,** Pasadena, for research and investigation of tunnel emission amplifiers.

## ARMY

**$1,589,144—Universal Molded Fiberglass Corp.,** Bristol, Va., for 96,137 shipping and firing containers for the *M55* rocket.

**$169,650—Telemeter Magnetics Inc.,** Los Angeles, for digital memory system.

**$120,000—Sperry Rand Corp.,** Salt Lake City, for publications for the *Sergeant* missile system.

**$119,490—Raytheon Co.,** Waltham, Mass., for replenishment repair parts for the *Hawk* system.

**$110,000—New Mexico State University,** University Park, for field testing and evaluation studies within the missile programs.

**$86,352—Radioplane Div., Northrop Corp.,** Van Nuys, Calif., for flight services for target missile.

**$61,000—The Martin Co.,** Orlando, for *Pershing* weapon system.

**$44,741—U.S. Steel Corp., Consolidated Western Steel Div.,** Los Angeles, for repair parts for rocket motors.

**$38,842—Sperry Rand Corp.,** Salt Lake City, for *Sergeant* missile ground handling equipment.

**$33,112—Douglas Aircraft Co.,** Santa Monica, for *Nike* replenishment spare parts.

## MISCELLANEOUS

**Chesapeake Instrument Corp.,** Shadyside, Md., for design, development and fabrication of an ultrasonic measuring system for determining the temperature of the combustion products developed in the motor tube of a rocket engine during the firing cycle. Awarded by **Allegany Ballistics Laboratory of Hercules Powder Co.** Amount not disclosed.


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# —when and where—

## FEBRUARY

**nstitute of Radio Engineers, Prof. Group on Military Electronics,** Los Angeles, Feb. 1-3.

**American Rocket Society, Solid Propellant Rocket Conference,** The Hotel Utah, Salt Lake City, Feb. 1-3.

**Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components, (unclassified), South Texas Section of SNT and Southwest Research Institute,** Gunter Hotel, San Antonio, Feb. 14-16.

**nstitute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting,** Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, Feb. 26-Mar. 1.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

## MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.

**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

**American Congress on Surveying and Mapping, and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 5-10.

**Symposium on Engineering Aspects of Magnetohydrodynamics, sponsored by PGNS, AIEE, IAS, University of Pennsylvania,** Philadelphia, Mar. 9-10.

**American Rocket Society, Test Operations and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

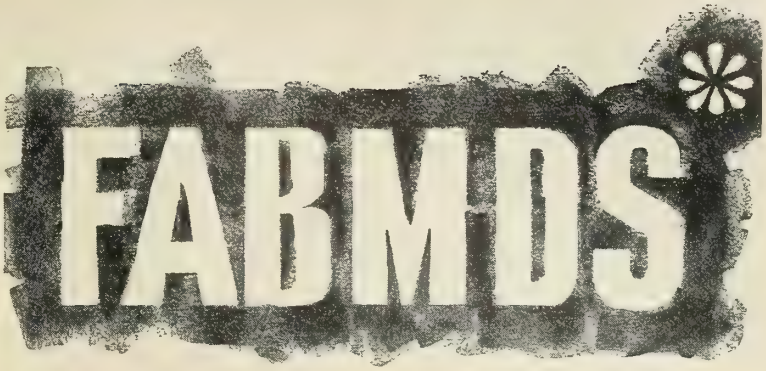
**American Society of Mechanical Engineers, Aviation Conference,** Statler Hotel, Buffalo, Mar. 13-17.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

**IRE International Convention, Coliseum and Waldorf-Astoria Hotel,** New York City, Mar. 20-23.

**Nuclear Congress, Nuclear Engineering and Science Conference sponsored by 30 major engineering societies and Engineers Joint Council,** Chicago, Mar. 20-24.

**American Society for Metals, 12th Western Metal Congress, Ambassador Hotel and Western Metal Exposition in Pan-Pacific Auditorium,** Los Angeles, Mar. 20-24.


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*Director, Technical and Research Staff*

Martin-Orlando's Technical and Research Staff has immediate openings for high level engineers and scientists in all 23 technologies being studied. Among these are:

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- **COMPUTER TECHNIQUES**—digital systems and logic design for unique weapon systems applications. Concept through prototype experience desired.

- **INFORMATION THEORY**—as applied to communications, guidance or radar systems with emphasis on information theory, information processing, statistical theory of communications, decision theory, optimum coding and detection.

- **INERTIAL GUIDANCE**—conceptual and analytical investigation of advanced inertial guidance systems. Experience should be in modern weapons systems with emphasis on systems analysis for employment of inertial guidance techniques, and/or conception and design of all or major portions of inertial guidance components.

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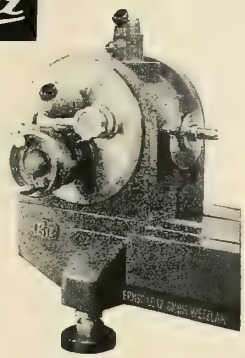
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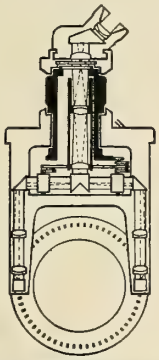
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Agency—J. Walter Thompson Co.

American Time Products, Inc. ..... 15
Agency—H. M. Alexander & Assoc., Adv. Agency

Calco Mfg. Co. ..... 14
Agency—Kreicker & Meloan, Inc.

Callery Chemical Co. ..... 66
Agency—Ketchum, MacLeod & Grove, Inc.

Chlor-Alkali Div., Food Machinery & Chemical Corp. .....20, 21
Agency—James J. McMahon, Inc.

Consolidated Electrodynamics Corp. 54
Agency—Hixson & Jorgensen, Inc.

Crystal Optics—Karl Lambrecht .... 60

Douglas Aircraft Co., Inc. ..... 23
Agency—J. Walter Thompson Co.

Electro-Mechanical Systems, Inc. ... 58
Agency—Charles F. Fry Adv. Assoc. Inc.

General Electric Co., Heavy Military Electronics Dept. ..... 57
Agency—George R. Nelson, Inc.

General Electric Co., Silicone Products Dept. ..... 22
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Agency—Campbell-Ewald Co.

Kaynar Mfg. Co., Inc. ..... 71
Agency—J. M. Straus & Co.

Lambrecht, Karl—Crystal Optics ... 60

Lear, Inc. ..... 18
Agency—Hixson & Jorgensen, Inc.

Lockheed Aircraft Corp., California Div. ..... 17
Agency—Hal Stebbins, Inc.

Martin Co. ..... 68
Agency—Ketchum, MacLeod & Grove, Inc.

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Agency—Carson/Roberts/Inc.

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Opto-Metric Tools, Inc. ..... 69
Agency—S. Frederic Auerbach Co., Inc.

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Agency—Maxwell Assoc., Inc.

Power Systems, Inc. ..... 64
Agency—The Kemble Co.

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Agency—Al Maescher Adv.

Radio Corp. of America, Airborne Systems Div. ..... 56

Industrial Electronic Products ..38, 39
Agency—Al Paul Lefton Co., Inc.

Remington Rand UNIVAC, Div.-Sperry Rand Corp. ..... 48
Agency—Mullen & Assoc., Inc.

Sigmund Cohn Corp. ..... 64
Agency—William G. Seidenbaum & Co.

Sperry Farragut Co., Div.-Sperry Rand Corp. ..... 4
Agency—Chirurg & Cairns, Inc.

Sperry Gyroscope Co., Div.-Sperry Rand Corp. ..... 40
Agency—Reach McClinton & Co., Inc.

Sundstrand Aviation-Denver ..... 2
Agency—William Kostka & Assoc., Inc.

Thiokol Chemical Corp., Rocket Div. 16
Agency—Hicks & Greist, Inc.

Vickers, Inc., Div.-Sperry Rand Corp. 59
Agency—Gray & Kilgore, Inc.

Washington Technological Assoc. .. 72
Agency—Dawson, MacLeod & Strivers

Western Electric Co. .....12, 13
Agency—Cunningham & Walsh, Inc.

Westinghouse Electric Corp., Aviation Industry ..... 43
Agency—Ketchum, MacLeod & Grove, Inc.

Vitro Labs., a Div. of Vitro Corp. of America ..... 24
Agency—Sam J. Gallay, Adv.

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General Electric Co.
Missile & Space Vehicle Dept. .. 3
Special Programs Section ..... 67
Agency—Deutsch & Shea, Inc.

# editorial . . .

## The *Nike-Zeus* Team

THE KENNEDY ADMINISTRATION is faced with a major decision on the *Nike-Zeus* program—concurrency or caution?

The urgent need for that decision is spelled out in the article by Defense Editor James Baar which leads off the special *Nike-Zeus* report beginning on p. 26 of this issue. The arguments for and against are clear. The decision should be made promptly.

Three months of editorial planning and thousands of miles of travel went into this 22-page special report. MISSILES AND ROCKETS editors visited *Nike-Zeus* facilities throughout the nation, talked to military experts concerned with the program and to dozens of the contractors and subcontractors working on the system. The result is the most comprehensive public report yet made on this controversial weapon system.

We are indebted to the Army and to the contractors for the full cooperation which made this possible.

Two things about the program particularly impressed us. One is the absolute confidence at every technical level that the *Nike-Zeus* system will work. If that confidence is justified, we can all sleep better at night. The other is the need for an immediate decision on production.

"How long can you hold a team together?" asked one manager. This was echoed elsewhere. In many ways, the *Nike-Zeus* team is the most experienced ever to work on a missile system. *Nike-Ajax* and *Hercules* provided valuable background. If a decision is delayed much longer, this team will begin to break up and drift away from the program. That would be tragic.

## The Pentagon Team

THE NEW DEFENSE TEAM moved into the Pentagon last week with the words of President Kennedy's inaugural address still echoing through the breadth of the land.

Certain of the words of the new Commander-in-Chief must have sounded like a mandate: never fear to negotiate but never negotiate through fear; peace—but peace based on strength.

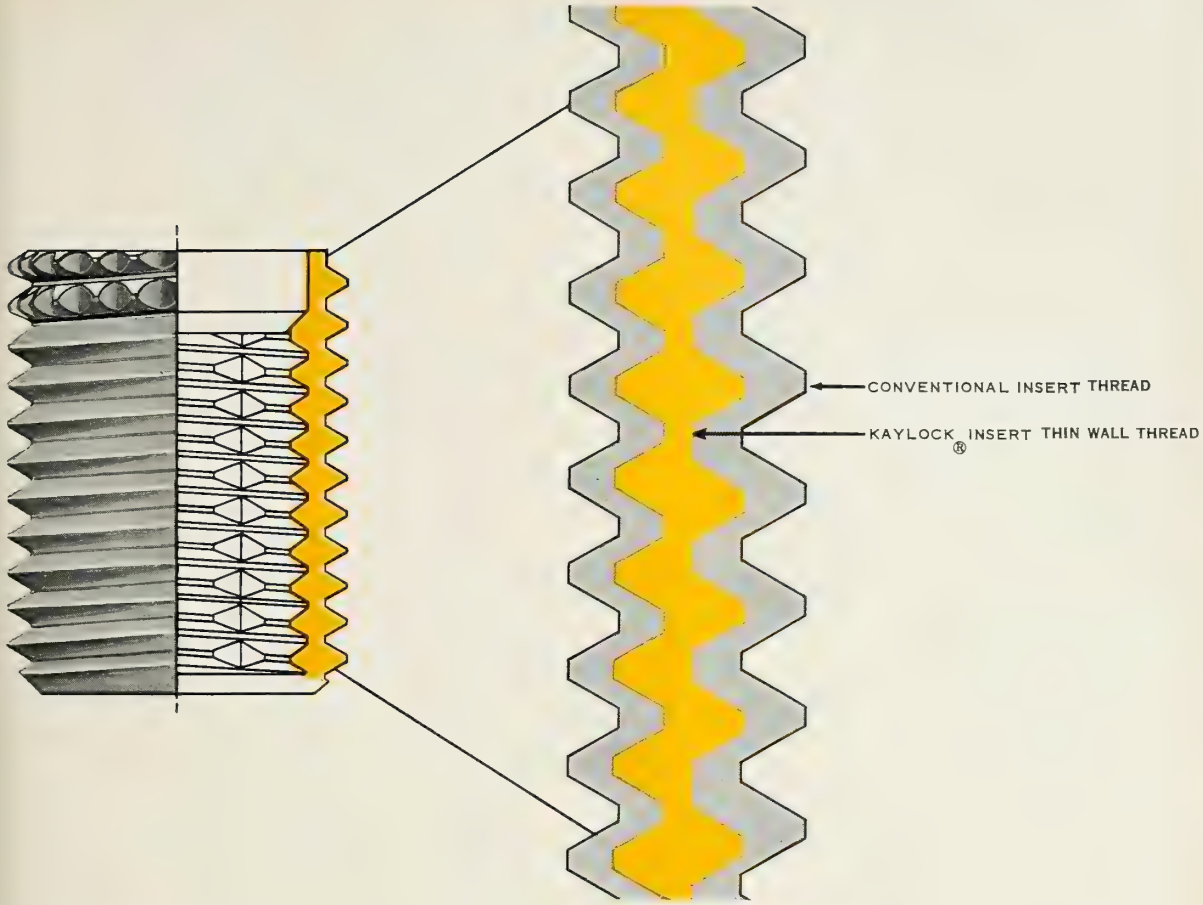
As Secretary of Defense Robert McNamara began his job, those who knew him expected him to move slowly but to move fairly. There were to be no big increases requested in the defense budget, no radical reorganizations of the U.S. defense structure sought in haste.

What were expected, though, were firm, hard decisions—a renouncement of vacillation. Said one member of the immediate defense team:

"You may want to say I'm wrong. You may want to say I'm intellectually stupid. But you'll never be able to say I failed to make decisions when they were needed."

McNamara was expected to organize his defense office along the lines most familiar to him —those of industry. As if the DOD were a corporation, McNamara will be president. Deputy Secretary Roswell L. Gilpatric will be vice president. The Secretaries of Army, Navy and Air Force—Elvis J. Stahr, John Connally and Eugene Zuckert—will be managers of divisions.

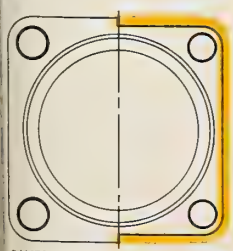
The new group will start, at least, with an attitude of "Don't try it—do it." There are many Pentagon people, many of them in the higher level posts, who will not fit into the concept McNamara & Co. have of the job to be done. They will not be permitted to linger.




# Kaynar introduces new thin wall insert

Look for the ultimate in weight and space savings when Kaynar introduces a new fastener! You'll find it in this new, high strength Kaylock® Thin Wall Insert! It embodies a design concept that in most cases permits one-thread size differential, I.D. to O.D. This feature makes it possible to reduce boss diameter requirements to an absolute minimum and still develop in the casting high strength potentials.

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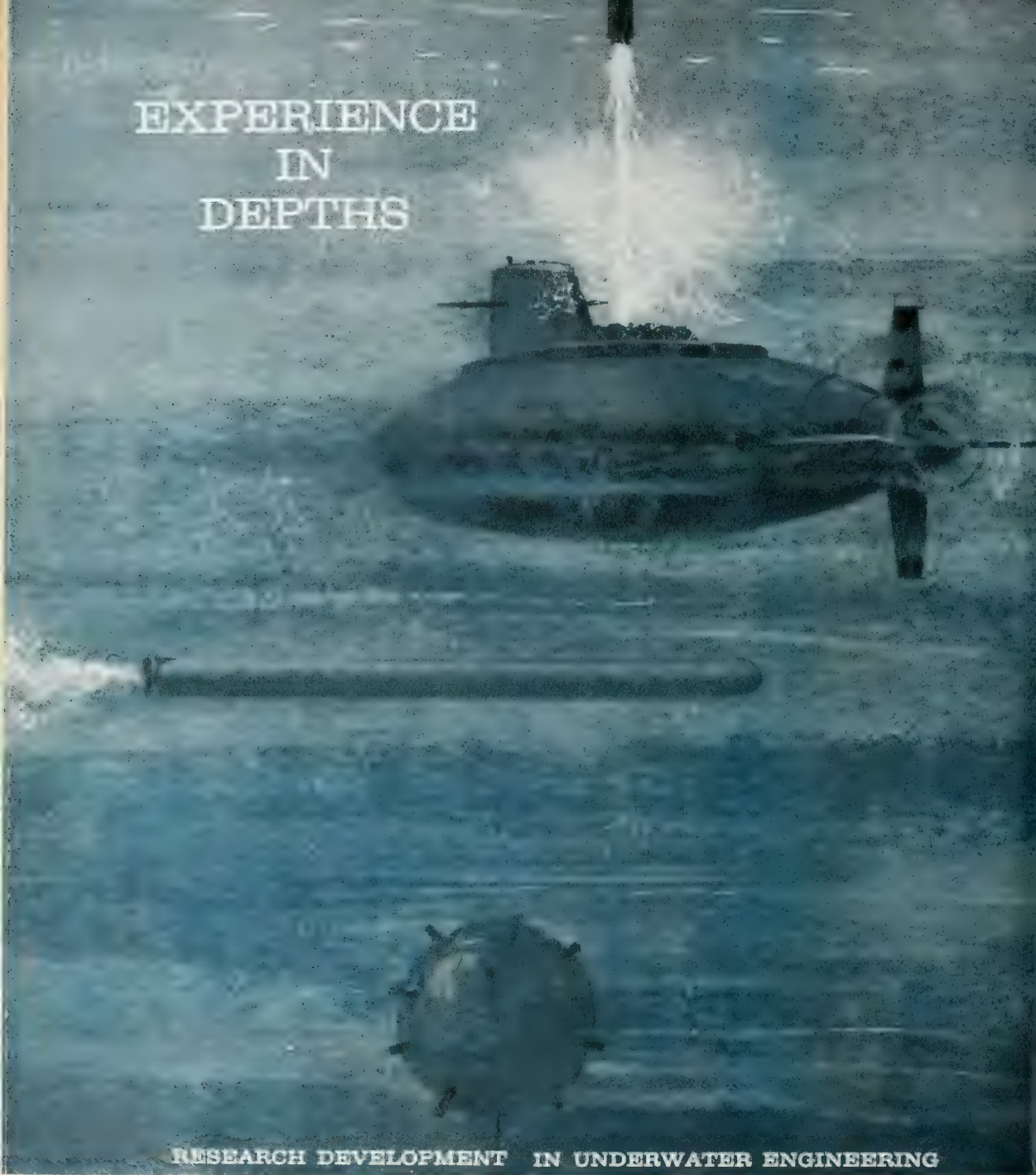




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FEBRUARY 6, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

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*ubic's Proposed SECOR Satellite*

Mercury, Minuteman, Samos Launchings Su
New Satellite Studied for Army SECOR . . 22
-15 Will Probe Puzzle of Gamma Rays . . 24

AN AMERICAN AVIATION PUBLICATION

Monsanto

Space-Age Project "HIGH-TEMP-LUBE"

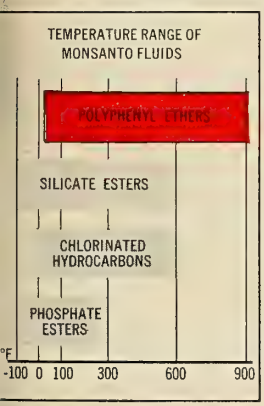
# A CHEMICAL EXPEDITION.



# .....seeking high-temperature lubricants for advanced jets and missiles...discovering new fluids that operate up to 900°F.

*Monsanto has established a base of "know-how" in a new area of synthetic fluids: the polyphenyl ethers, fluids that exceed the high-temperature performance of all other known lubricants and hydraulic fluids. These newly synthesized liquids resist radiation damage, oxidation and chemical decomposition: as liquids they cover a temperature range of 20° F. to 900° F. Polyphenyl ethers are the result of creative chemistry applied to the problem of high-temperature lubricants; they were developed under contract and in cooperation with Wright Air Development Division, U. S. Air Force.*

The heat stability of Monsanto's polyphenyl ethers is the result of enlisting chemical know-how on a problem of mechanical engineering. By design, lubricants for jet engines (and liquid fuel missiles) must lubricate and cool the bearings and accessory drive gears. Existing lubricants could not meet the requirements of advanced engine design. So the logical step was a Monsanto expedition into little-known fields of chemistry. A team of Monsanto scientists found and developed the polyphenyl ethers: to date, nineteen new compositions of matter.




In comparison with other synthetics, these lubricants are as thermally stable at 840° F., as are silicones and petroleum hydrocarbons at 740° F., and present commercial diesters at 540° F. Their useful temperature range exceeds all other fluids by 100° to 400° F.

Their chemical stability, physical properties, and lubricity recommend them for a host of other fluid applications: "hot" hydraulic systems; base stocks for high-temperature and/or radiation-resistant greases; and heat-transfer fluids.

Until development of the polyphenyl ethers, the calculated* useful life of the *best* synthetic lubricant was a scant 18 minutes at 900° F. Presently used synthetic lubricants would be effective for only 6 seconds to 3 minutes at this temperature. Polyphenyl ethers, however, would have useful lives of *20-80 hours* at 900° F.

*Based on the activation energy derived from isoteniscope data.

THERMAL STABILITY OF POLYPHENYL ETHERS VERSUS OTHER SYNTHETIC LUBRICANTS

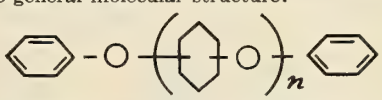
| Compound | Decomposition Point, °F. | Useful Life at 900° F.* |
|---|---|---|
| Bis (p-phenoxyphenyl) ether | 824 | 25 hours |
| m-Bis (m-phenoxyphenoxy) benzene | 862 | 80 hours |
| Bis-p (m-phenoxyphenoxy) phenyl ether | 832 | 20 hours |
| Quaterphenyl | 826 | 30 hours |
| Silicone | 740 | 18 minutes |
| n-Octacosane | 662 | 3 minutes |
| Tetra (2-ethylhexyl) silicate | 638 | 14.4 seconds |
| Pentaerythritol tetrahexanoate | 585 | 7.2 seconds |
| Bis (2-ethylhexyl) sebacate | 525 | 7.2 seconds |

**Time to decompose 10%*

Heat stability is one important facet of these new molecules. The polyphenyl ethers also match the lubricity and viscosity indexes of other good lubricants and possess better hydrolytic stability. They are two to five times more stable than most other synthetic fluids under nuclear radiation.

## THE PROPERTIES OF THE MOLECULES

The unsubstituted polyphenyl ethers have the general molecular structure:



The "*n*" values range from 1 to 8, each with linkages in various combinations of the *ortho*, *meta* and *para* positions. The various isomeric polyphenyl ethers are all good lubricants: they show heat stability within a narrow range (the 7-ring ether decomposes only 20° F. higher than the 4-ring ether; a 5-ring appears to have the optimum thermal stability).

Varying the chain length does not materially affect lubricity or heat stability—as chain length increases so does pourpoint, and, conversely, volatility decreases. A 7-ring *meta* ether boils at 1150° F., has a pourpoint of 70° F. Chemically "tailoring" and blending can provide optimum lubricant properties.

While the properties of these fluids may solve many needs, the chemical expedition which found them set out to answer the specific problem of advanced turbojet engine and accessory lubrication. Turbine bearings, surrounded by hot gases, must be kept clean, cool and smooth-spinning. (*Please turn page.*)

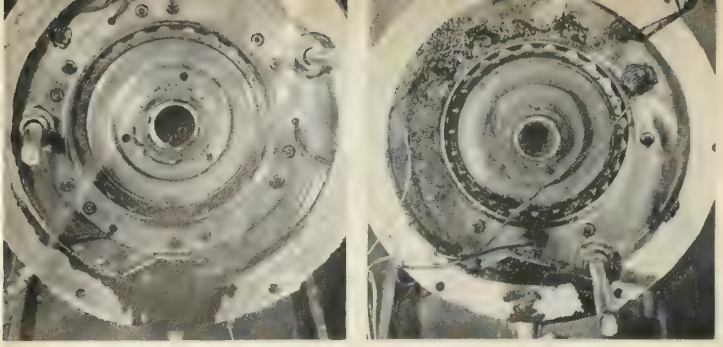


Photo Courtesy Pratt & Whitney Aircraft

Test rig parts for evaluating thermal and oxidative stability and lubrication properties of jet engine lubricants show how a polyphenyl ether (left) leaves the rig parts clean, free of deposits, and with no evidence of wear. Photo at right shows deposits and general condition of parts using one of the best synthetic lubricants prior to development of polyphenyl ethers. Both tests were run at a bearing temperature of 500° F. for 100 hours at a speed of 10,000 RPM.

Between Mach 3 and Mach 4, the skin temperature of craft in sustained flight at 40,000 feet can rise to 900° F., the temperature where steel glows red. In the lubricant reservoir, the polyphenyl ethers withstand this stress. Consequently, for speed brakes, hydraulic controls, fuel pumps and other internal moving parts, polyphenyl ethers can cope with the "heat barrier" to provide reliable performance.

Monsanto's polyphenyl ethers are a new link in the design chain leading to advanced engines and weapons systems with a minimum of "compromise" for lubricant and hydraulic fluid limitations. In present systems just "getting by" with marginal performance of earlier lubricants, the polyphenyl ethers can provide greater reliability.




## SYNTHETIC FLUIDS FOR SPACE-AGE ENGINEERING

Monsanto has had 15 years' experience in the development of synthetic fluids and lubricants; currently markets over 20 fluids with applications that range from electronic coolant-dielectrics to fire-resistant hydraulic fluids for jets and radiation-resistant fluids for nuclear power plants.

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 6 February 6, 1961

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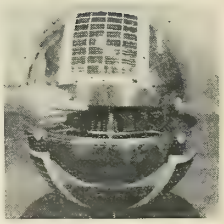
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## THE COVER

*View of satellite assembly built by Cubic Corp., being studied as configuration for Army's SECOR precision mapping program. Note solar cells. Story starts on page 22.*

## FEBRUARY 6 HEADLINES

Manned Mercury Shot Could Come Within 60 Days .. 12
Complete Minuteman Passes Its First Flight Test .... 14
Samos Carries Cameras In Orbit Over Soviet Union .. 15
Europeans Debate British Plan For Space 'Club' .... 15
Kennedy Speech Calls For Bolstering Defenses .... 16
Webb Surprise Choice For NASA Administrator .... 17
Government Sees Record Electronics Output In '61 .. 18
Air Force, Navy Share Mercury Rescue Assignment .. 36
NASA Prepares To Ask For Supplementary Funding .. 42

## SPACE SYSTEMS

New Satellite Configuration Studied for SECOR .... 22
NASA's S-15 Will Investigate Gamma Ray Mystery .. 24

## ENGINEERING

Measurement Standards Inadequate for Space Age .. 26

## ADVANCED MATERIALS†

Boeing Experiments with Glass Fiber Fuel Tanks .... 28
Air Force Looks for Fiber to Replace Nylon ..... 28
Lockheed Builds Antennas of Mylar and Aluminum .. 28

## ELECTRONICS

Microdot Gages Will Record Strains on Dyna-Soar .. 30

## PROPULSION ENGINEERING*

NASA Seeks Wings for Dry Landings of Saturn ..... 32
Geckler Says Solids Would Cut Big Booster Costs .... 32

## GUIDANCE

Mobile Minuteman Has Built-in Optical Alinement .. 33

## INTERNATIONAL

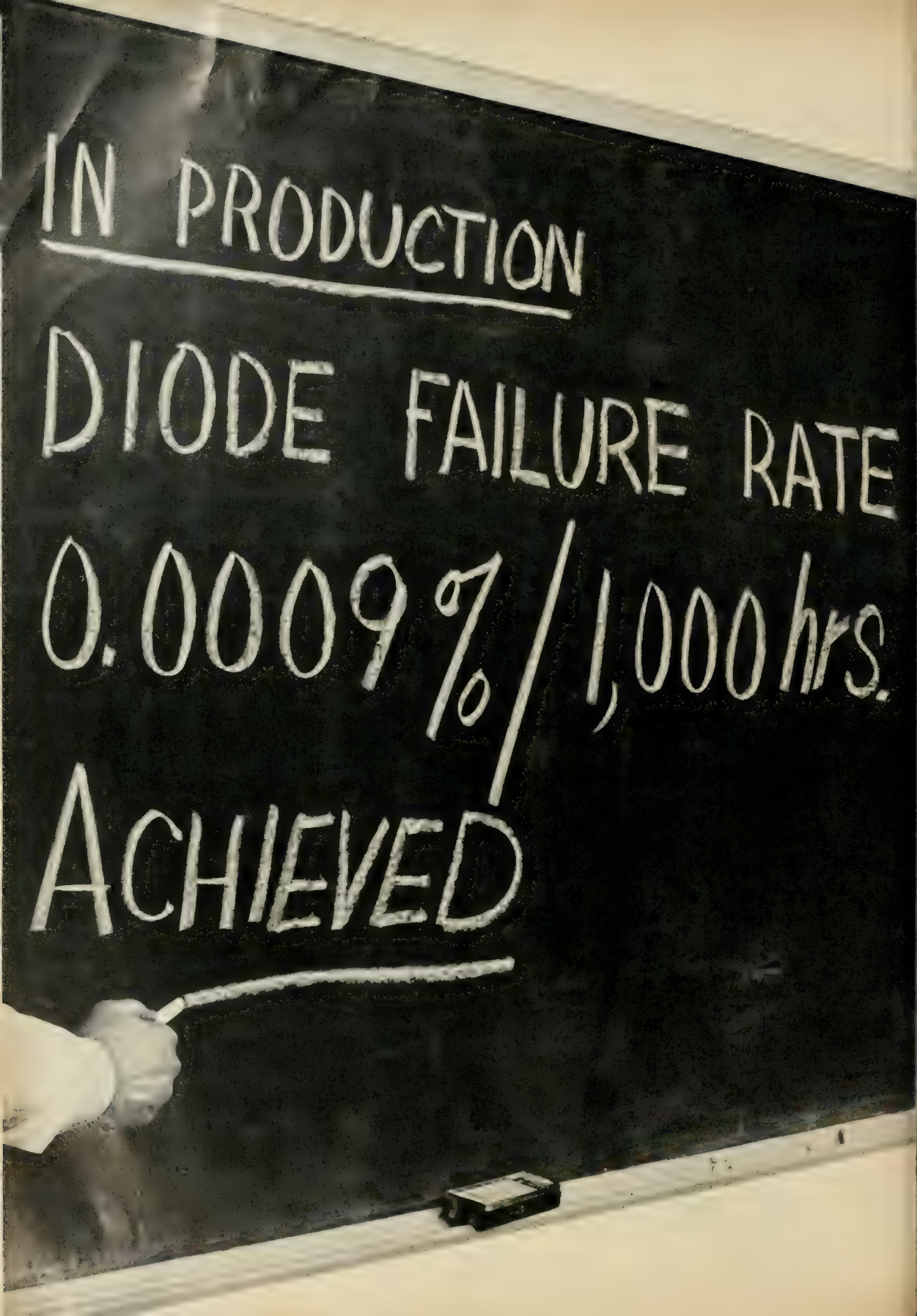
De Gaulle Plan Will Make France a Missile Power .. ..

## DEPARTMENTS

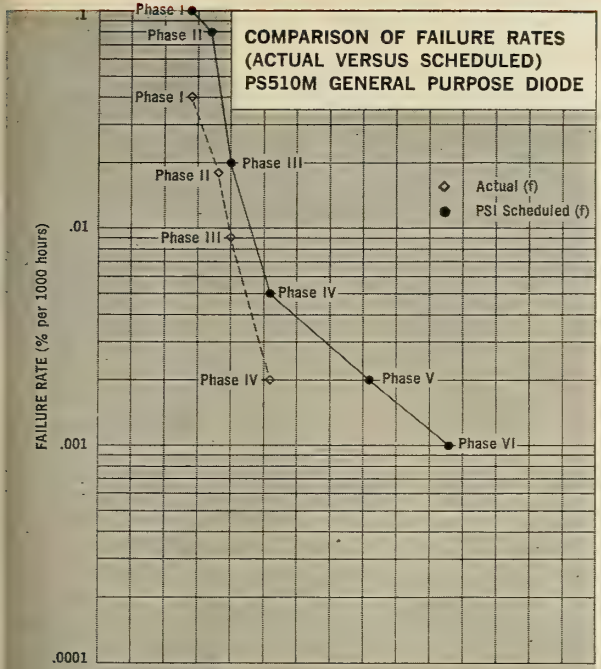
The Missile/Space Week† ..... 8
The Countdown ..... 11
Technical Countdown .. 21
Contracts ..... 44
When and Where .... 44
Names in the News .. 45
Products & Processes .. 46
Letters ..... 48
Editorial ..... 50

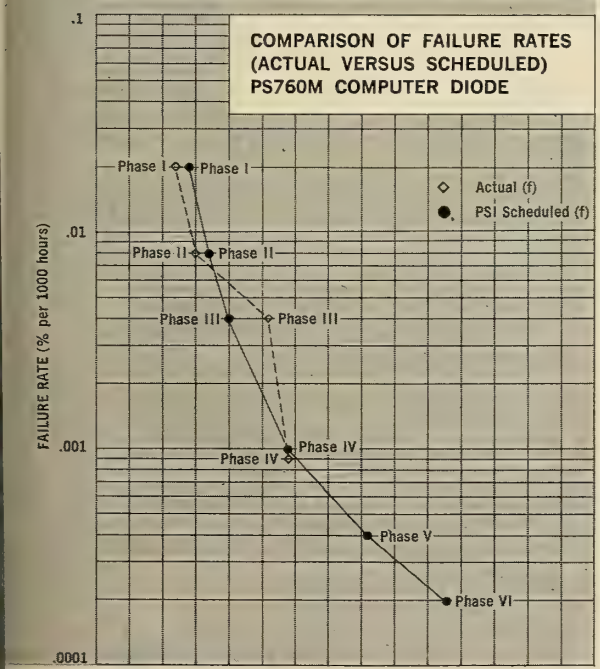
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DIODE FAILURE RATE
0.0009%/1,000hrs.
ACHIEVED

# RELIABILITY...PROVED




## PACIFIC SEMICONDUCTORS, INC., tests indicate failure rate of .0009% per 1,000 hours ACHIEVED for silicon computer diodes... .002% per 1,000 hours ACHIEVED for silicon general purpose diodes

PSI—qualified supplier of all silicon computer and general purpose diodes for the "Minuteman" ICBM guidance system—has undertaken a production and evaluation program designed to furnish "Minuteman" with ultra-high-reliability diodes. The program is being supported by the Air Force Ballistic Missile Division through the Autonetics Division of North American Aviation.

The ultimate reliability objective is a maximum failure rate of .0002% per 1,000 hours for silicon computer diodes, and .001% per 1,000 hours for silicon general purpose diodes—levels heretofore unattainable in the semiconductor industry. To achieve and prove this objective, more than 250,000 silicon diodes are being used to generate in excess of a billion diode hours of test information.

Results to date indicate that PSI is currently supplying "Minuteman" computer diodes with an indicated failure rate of .0009% per 1.000 hours, and general purpose diodes with an indicated failure rate of .002% per 1,000 hours.

Because of the huge quantity of high reliability diodes required in the "Minuteman" program, PSI has been able to make thousands of diode measurements and use these data to control processes. Since the same controls are applied to *all* PSI manufacturing processes — and *not just to a limited and specially isolated line*—PSI is able to supply high-reliability silicon diodes in large quantities and on a regular basis.

If you are associated with a program requiring ultra-high reliability semiconductor devices, you are invited to take advantage of the vast and growing fund of information and large volume production capacity available only at PSI. For full details, write to Richard A. Campbell, Executive Vice President, Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, California (Los Angeles County).

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# The Missile/Space Week

## New Space Probe

Within a few days, NASA expects to launch its *S-45* ionosphere beacon satellite. The 74-lb spacecraft—lofted by a *Juno II*—will transmit on six frequencies at varying power levels. This will enable ground stations to analyze the nature of the ionosphere as the *S-45* orbits at an apogee of 1600 miles and perigee of 240 miles in a 116-min. period.

The spacecraft is shaped like two truncated cones, back to back. It resembles *Explorers VII* and *VIII*. A 6-ft. loop antenna around its equator transmits low-frequency signals.

## Nuclear Rocket Bids Due

The Atomic Energy Commission and NASA are inviting proposals by April 3 on research and development of a nuclear rocket engine.

Selection will be based on winners ability to carry out the entire engine development program which may run five years or more. Contract being awarded this year, however, will cover only the first phase, including assistance to the Los Alamos Scientific Laboratory in conducting the *KIWI B* test program and R&D on non-nuclear components. AEC-NASA nuclear propulsion office headed by Harold B. Finger is handling the contract.

## 'Cosmonaut'—Not Yet

Leading Soviet Scientist Yevgeny Federov says "much time is still needed" before the Russians will be able to orbit an astronaut.

The statement made in Moscow was an apparent attempt to debunk rumors that the Soviets had not only attempted at least one manned launch but had failed in returning the vehicles and sacrificed the passengers.

However, the Academy of Sciences Scientific Secretary said that the Soviets' success in orbiting biological specimens "has made it possible to be confident in the possibility of manned space flight." He cited the dangers of the return to earth as a factor which needs research before manned flight is possible.

## Shots of the Week

The first tactical model Air Force *Bomarc-B* interceptor missile was successfully launched at Eglin AFB. At an altitude of nearly seven miles over the Gulf of Mexico, the missile made a scheduled near-miss intercept of a supersonic *Regulus I* drone travelling at almost 800 mph. The shot capped a week in which

An Air Force *Minuteman* loaded with 400 lbs. of test equipment, passed its first full-scale flight test of 4200 miles. NASA recovered its chimpanzee "Ham" after the animal enjoyed a successful, although extended (by 130 miles) trip of 420 miles in *MR-2*. At Point Arguello, an *Atlas Agena* lofted an Air Force *Samos* reconnaissance satellite into polar orbit. And back at the Cape, the 34-ft. Army *Pershing* (8 for 11) scored again in a 150-mile test of a new guidance system. It was fired from its transporter-launcher-erector.

The week also marked the third birthday (Jan. 31) of *Explorer I*, free world's first scientific earth satellite. The 18.13-lb. satellite, though it ceased transmitting 6½ days after launch, is expected to last four to seven years longer and circles the earth 13 times a day.

## More on Ball Lightning

Soviet research into the possibility of using lightning as a weapon has produced equipment for conducting a relatively small ball of lightning to undisclosed distances from a generating tube. A report, although sketchy in details, appears to bear out earlier belief (M/R, Aug. 24, 1959, p. 13) that such weapon applications were being developed by Soviet researchers.

Soviet scientists have reported that the lightning balls explode when they come in contact with catalyzers releasing considerable energy.

Equipment for the experimental device is described as "a quartz tube with a special profile and with a heat resistant non-conducting core which carries electric arcs.



*M/R EDITOR COUGHLIN (standing) discusses layout with News Editor Reed Bundy and Managing Editor Bill Howard.*

# *memo from the publisher*

This week we introduce William J. Coughlin as M/R's new Editor.

Already well known in missile/space industry circles, Bill has included an enormous amount of traveling in his 15 years of very active reporting before landing in the editor's chair here in Washington.

While most of his journeys in the past few years have kept him close to the heart of the missile/-space industry in Southern California, Washington D.C., and the nation's various missile test ranges, he can boast of having toured more than 30 countries on both sides of the Iron Curtain.

Bill has hunted moose in Alaska —flying a P-38 armed with camera instead of guns; switched to an aqualung to chase whales off the coast of Mexico. He has banged vodka glasses with Premier Khrushchev at a Moscow diplomatic reception and his was the first American family to make the trip to the Russian capital by car, as one London newspaper put it, "since the days of the Tsar." He is one of the few men to have explored the sunken hulk of the battleship Arizona at the bottom of Pearl Harbor.

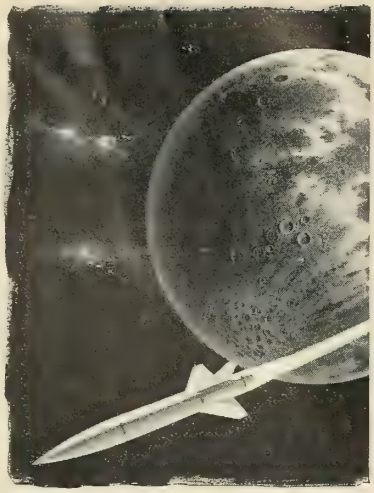
After four years in the Air Force during World War II as a fighter pilot, Coughlin joined United Press, covered the Pacific for three years, later becoming UPI's San Francisco bureau manager. He held a Melville Jacoby journalism fellowship at Stanford University, of which he is a graduate. He has authored a book on Japan and his articles have appeared in such publications as *Readers' Digest* and *Harper's* magazine.

Bill was London and Moscow bureau chief for the McGraw-Hill Publishing Company before joining us here at American Aviation Publications. His military experience includes tours as a war correspondent in Korea and in Egypt during the 1956 Suez action. He has spent more than five years covering the aviation and missile/space industries on the West Coast, the last two of them as our West Coast bureau Chief. For several years, he was a regional director for the Aviation/-Space Writers Association.

Bill is married; his wife Gerry and their three children soon will be joining him in Washington.

Clarke Newlon, who has been Executive Editor of MISSILES & ROCKETS since September, 1958, has resigned from the M/R staff to accept the position of Consultant for Military Affairs for American Aviation Publications, our parent organization. We will continue to make good use of his wide range of military and missile/space industry experience.

Edwards Mudgett

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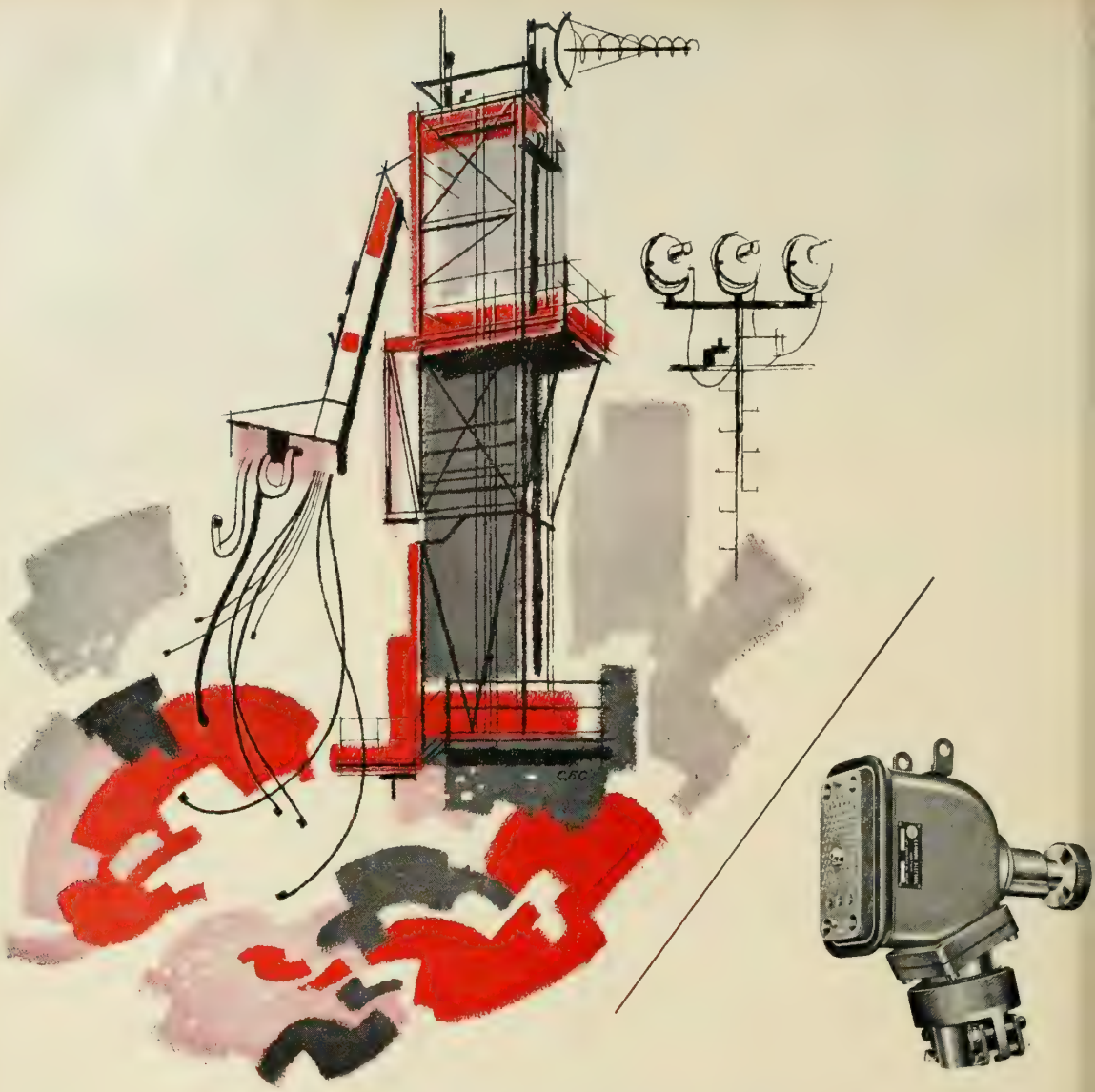
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CANNON PLUGS



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# The Countdown

## WASHINGTON

### Waiting for McNamara

The Kennedy-ordered review by Defense Secretary McNamara of all U.S. Defenses and U.S. defense strategy all but killed the possibility that Kennedy will seek a supplemental defense money bill for FY '61. The House Defense Appropriations Subcommittee is beginning hearings on the final Eisenhower defense budget. Other committees plan some tentative hearings on various aspects of the nation's defense and space programs. But, in general, everyone on the Hill is waiting for McNamara's report at the end of the month.

### The Coming Gardner Report

One powerful input certain to be fed into the considerations of Secretary McNamara and his task forces will be the Gardner report on the Air Force's future needs in space. A high-powered committee headed by former Air Force R&D Secretary Trevor Gardner and including Presidential Science Adviser Jerome Wiesner is scheduled to complete the report and hand it to the Air Force in a matter of days. It is expected to advocate the need for both offensive and defensive military systems—manned and unmanned.

### Polaris Cruisers: How Much?

The cost of putting eight Lockheed *Polarises* aboard the nuclear-powered cruiser Long Beach will be about $55 million. But the cost of deploying *Polaris* aboard other missile cruisers would be considerably less. Previous estimates for proposals that at least until now have been shelved say the pricetag for the first one would be about $49 million—the rest about $37 million.

### Sky Bolt Bombers: When?

An Avro RAF Vulcan is being checked by Douglas for compatibility with the *Sky Bolt* ALBM. The program is moving ahead. But the essential point that still must be faced by the Kennedy Administration is that the *Sky Bolt* will be ready later rather than sooner, unless present funding propopsals are reversed. The 1964 target date looks less and less likely.

### Victims for Zeus Arrive

The first two *Atlases* that will be used as targets in the *Nike-Zeus* Pacific tests are reported to have arrived at Convair's San Diego plant for modification. Their re-entry vehicles will be made capable of simulating decoys. Their guidance systems also are expected to be modified or possibly replaced. The first *Zeus* vs. *Atlas* tests may come late this year.

### Red General Prowls the West

Air Force Gen. Mikhail N. Kostiuk, air attache to the Soviet Embassy in Washington, showed up this last week at the ARS meeting in Salt Lake City shadowed by CIA agents. Theme of the meeting: solid propulsion. Asked if Russia were particularly interested in solids, Kostiuk replied affably: "If I knew I would tell you, but I don't know."

## INDUSTRY

### Threat from Abroad

Many missile makers are becoming increasingly concerned over foreign competition. "We've got to look out," says one project manager, "that we don't price ourselves out of the market." While the military services are pressing hard on cutting costs, this manufacturer believes loss of business to foreign concerns—particularly in the missile component area—will be the greatest spur to lower prices.

### Mahogany Row

Major reorganization of General Dynamics electronics activities may pressage a company drive to become a system bidder on upcoming space contracts. G-D is setting up a new division, which will absorb its Stromberg-Carlson division and all other electronics manufacturing throughout the company. James D. McLean, president and general manager of Stromberg-Carlson, moves over as chief of the new General Dynamics/Electronics . . . North American Aviation is letting it be known that it is looking for "the right" growth company to buy so it can expand in commercial fields . . . McDonnell Aircraft has set up a new Electronics Equipment Division.

### Where Did He Go?

Dr. G. B. Kistiakowsky, Presidential Science Adviser to Eisenhower and one of the most powerful members of the Eisenhower Administration, is now chairman of Itek Corp.'s new science board and an Itek director. The science board will assist Itek directors in guiding and evaluating technical programs.

### Double Jeopardy Here to Stay

All signs are pointing to full use by Congress of its new rule that procurement of missiles, aircraft and ships must now be authorized as well as funded despite objections from the Pentagon and the outgoing Eisenhower Administration. That means programs will have to go before two committees in each house instead of one. However, at least at first, it looks as if procurement will be authorized in dollars rather than items.

## INTERNATIONAL

### France's Space Program

French scientists are planning to launch about a dozen high altitude probes this year—five of them *Veroniques*. The new Program Law (see page 40) sets aside $26 million for space research over the next five years. Once fully under way, about 50 probes a year will be launched. But there is no money as yet for satellites which would enable the French to join in Britain's proposed "space club."

### New Sounding Rockets

Two new sounding rockets expected to be used in the French space program are Sud Aviation's *Bélier* and *Centaure*. Experiments will study explosions at high altitude and ionization layers formed around re-entry vehicles.

### Overseas Pipeline

Aerojet-General is licensing SETEL of France to produce *Hawk* antiaircraft missile motors . . . Britain's Royal Radar Establishiment is developing a camera to photograph ninth and tenth magnitude satellites with an accuracy within 2 sec. of arc . . . Using a copper-plating technique, the Russians are now drawing aluminum wire to 5-7 microns in diameter.

*'Ham' shows the way . . .*

# Manned Shot Could Come Soon

***MR-2 success—despite faulty rocket performance—boosts prospects that U.S. may yet win race to launch and recover a human***



*SMILING CHIMP lies in life couch before being put aboard capsule.*



*COMPONENTS OF chimpanzee couch and life support system laid out before flight.*

**by Hal Gettings**

CAPE CANAVERAL—With the last major obstacle out of the way, an astronaut now seems certain to attempt America's first manned ballistic space flight soon—perhaps within 60 days.

One comparatively minor flight test—the final qualification of the *Mercury* capsule escape system with a *Little Joe* rocket—remains.

The success of last week's *Mercury Redstone 2*—despite faulty operation of the *Redstone* rocket—gave conclusive proof that a manlike animal can survive and perform at his normal capacity during five minutes of weightlessness in a space environment. The results spurred hope that America will win the race with Russia to put a man in space and return him safely.

Ham, the 37-lb., 3¾-year-old male chimpanzee who rode in the *MR-2* capsule, is one of the largest animals ever brought back from space alive. The dogs returned from last summer's Soviet orbital flight weighed only 10 to 15 lbs.

• **Slow progress**—The *Redstone* phase of the *Mercury* program, which slipped six months to a year behind early optimistic schedules last year, now is moving along steadily. There is still no word when *Atlas* flights will be resumed, although a decision on the scheduling of the next *Atlas* flight is expected soon. Manned orbital flight is still officially targeted for the end of 1961, but early 1962 now seems to be the earliest possible date.

The *Little Joe* test, to be launched from Wallops Island, will subject the escape system to the most severe conditions that might be anticipated in an abort during boost by an *Atlas* for an orbital flight. Thus it is not a basic part of the *Mercury Redstone* qualification program.

Nevertheless, National Aeronautics and Space Administration officials will await the results of the *Little Joe* flight before completing arrangements for the manned *Mercury Redstone 3*. In point of fact, no formal decision has been made to put an astronaut aboard *MR-3*. Careful studies must be made of the telemetry, capsule and chim-

anzee from the Jan. 31 *MR-2* flight. ut in view of the obvious success of its ajor endeavor—to show that the apsule is capable of supporting a man-ke creature—there is little doubt of ie decision.

• **Gain from malfunction**—The ulty operation of the specially modi-ed *Redstone* actually provided a bonus i proving out the capsule escape ystem in the *MR-2* flight. It worked erfectly.

The *Redstone* engine thrust regu-tor failed to hold thrust within de-red limits. As a result, propellant was onsumed too fast and LOX ran out bout five seconds sooner than pro-ramed. The early burnout—a second r two sooner than the programed tol-rance of the abort sensing system—reated a "red line" situation that auto-natically fired the escape rockets.

To reduce capsule weight to a inimum, the posigrade and retro-ocket package is left behind when the scape system is fired. Thus, when the scape rockets were fired at 200,000 . after about 140 seconds of powered ight, they cut out the possibility of etro-firing to slow the capsule for re-ntry. And, since there was virtually o atmosphere at that altitude, the arachutes did not deploy until re-ntry.

The excessive *Redstone* thrust added bout 700 fps to the programed vel-city of 6500 fps (4400 mph). The scape rockets added about 500 fps. he absence of retrorockets eliminated ie possibility of slowing the capsule by bout 500 fps at apogee.

As a result, the capsule was travel-ing at more than 500 mph after apogee —about 1700 fps faster than pro-gramed. As a result, it rose to an alti-tude of 155 statute miles instead of 115, and traveled 420 miles down the Atlantic Missile Range, 130 miles be-yond the area where seven vessels of the Navy's Destroyer Flotilla 4 were waiting.

• **Well and happy**—Search planes spotted it in the water less than an hour after the 11:15 A.M. (EST) launch. The fleet steamed to the area, about 175 miles east of Grand Bahama, and the USS Ellison sighted the cap-sule floating on its side at 2:30 P.M. Two sailors in a rubber raft put a line on and righted it in the water. Then a helipcoter picked the capsule up at 2:52 and placed it on the deck of the USS Donner at 3:41 P.M., just 3 hours and 46 minutes after launch.

Maj. R. E. Benson, Air Force vet-erinarian, examined the animal, pro-nounced him in good condition and approved a supper consisting of an apple, a half orange, a small wedge of lettuce and not more than 300 cc of water for the first six hours. The animal appeared lively and ate the meal.

Ham spent the night aboard the Donner and was flown to Grand Bahama by helicopter the following morning. Later that day, he was re-turned to the Cape for a further flight to his base at Holloman AFB, N.M.

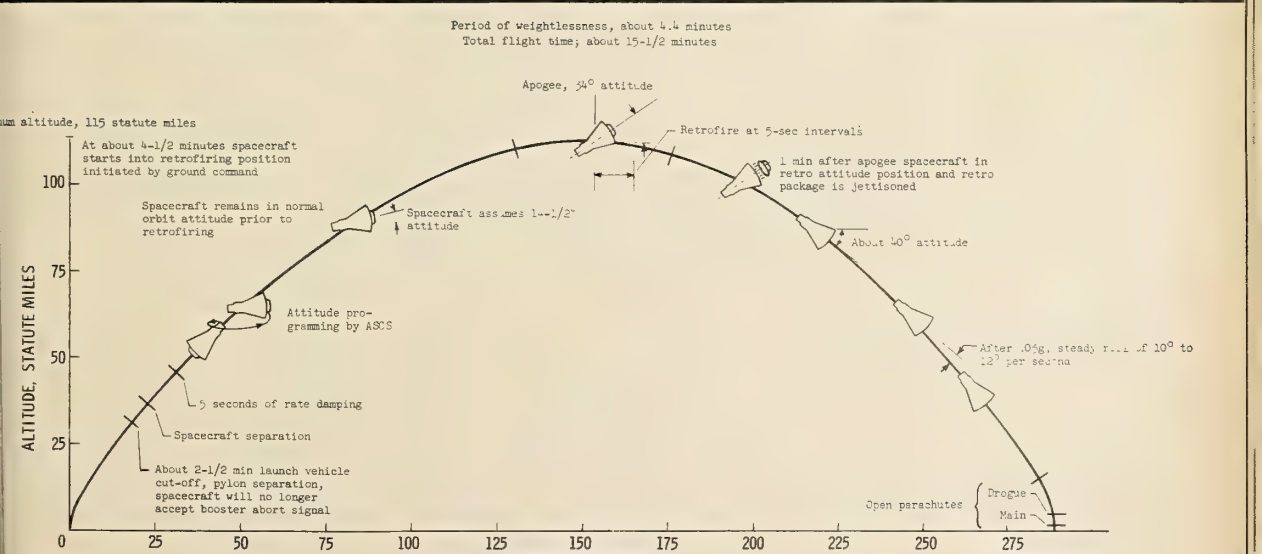
George M. Low, chief of manned space flight at NASA headquarters, re-ported that the animal apparently per-formed perfectly in its little game with flashing lights. Observers at the com-mand console saw no indication that he failed to react to stimuli during boost, free flight and re-entry, although he had to withstand a greater re-entry stress than the expected 7 g.

• **New escape test**—The *Little Joe* flight—which may come as soon as next week—is a repeat of the unsuc-cessful *Little Joe 5* last Nov. 8. It will test the booster separation and escape systems that almost duplicate the most severe conditions it might encounter as it leaves the atmosphere.

In the Nov. 8 flight, the escape rocket received a premature signal and fired before the capsule had been sep-arated from the *Little Joe* booster by the firing of explosive bolts to release the clamp ring. As a result, the escape rocket merely added to the velocity of the whole vehicle. Later, the bolts re-leased the clamp ring at the proper time and gave another signal to fire the escape rocket, but it had already burned out.

The trouble was quickly located and the electronic circuits were rewound in time for the first attempt at firing *MR-1* on Nov. 21. The electronic system now has worked properly on two flights, *MR-1* and *MR-2*. The only question remaining to be settled by *Little Joe 6* is whether the system will work under maximum aerodunamic Load.

Low said there is a possibility that the second *Mercury Atlas* will also be launched before the manned *Redstone*. But he said the manned flight will not wait for the *Atlas*, since the *Redstone* and *Atlas* programs are separate from one another. ⌘




NORMAL SEQUENCE OF EVENTS FOR MERCURY-REDSTONE FLIGHT

*ROGRAMED FLIGHT PLAN called for capsule to travel 290 miles. It went 420 miles, was recovered in 3 hours, 46 minutes.*

# Minuteman Passes First Flight Test

***Success in full-scale shot scores a missile 'first'—near-operational 1st stage is being modified***



*NEXT BIG TEST for Minuteman will be shot later this year from launch car made by ACF Industries and American Machine & Foundry. Car cost about $1 million.*

STILL FLUSHED with the success of the first complete R&D launching of a *Minuteman*, the Air Force is pressing ahead with plans to make improvements in the big ICBM's first-stage motor.

However, it was made clear that the improvements would not be made until well into the planned two-year test program—probably early next year.

The present test schedule calls for at least several more launchings from pads at Cape Canaveral, and then a new series from an operational-type silo beginning this summer.

The exact nature of the planned changes was not disclosed. But the Air Force stressed that the *Minuteman* launched from the Cape Feb. 1 was a "virtually operational" bird.

The launching marked the first time in a major missile R&D program in which a complete bird was flown.

All three stages of the *Minuteman* ignited successfully in the test flight, and it impacted in the programed target area 4200 miles down-range.

The test bird carried an 18-in.-long instrumentation section between the guidance section and third-stage engine. This package contained the radio tracking system, optical beacon, and command-destruct, telemetering, and power systems.

Instrumentation antennas, designed to protrude from the section rather than be flush-mounted—in order to save weight and space—are covered with an ablation material for heat protection. The ground system used in the test firing is essentially the same as the operational equipment.

• **Some firsts**—The solid-fueled 6300-mile *Minuteman* boasts several important firsts in its design.

The first stage is the largest solid engine with the highest $I_{sp}$ propellant ever flown. It is the first solid engine to use movable nozzles for thrust-vector control.

The thin-walled steel case serves as the body of the engine—eliminating the need for an airframe as such. This allows assembly of the missile at the test site—as was done here for this test shot.

Use of the operational guidance and control system in the test flight also marks a significant first. The G&C system is integrated with a solid-stage digital computer which takes information from velocity meters and uses it to generate steering signals and staging and thrust-termination signals.

After first-stage burnout, the G&C system senses the rust decay and ignites the second stage at the proper point (about T plus one minute). The same procedure ignites the third stage.

• **'Bold approach'**—Primary objective of this first test firing was to test first-stage ignition, lift-off, launch technique, prelaunch checkout, and instrumentation. Secondary objectives—considered a bonus in this shot—were second- and third-stage performance and overall operation.

Design and test philosophy of the *Minuteman* centers around what Col. Sam Phillips, director of the Weapon System Program, calls the "bold approach." Principally, this means going all-out on new and different concepts: the remote silo and train launch, movable nozzles, integrated G&C, and full-scale flight-test vehicles.

"Concurrency and compression" is the theme of the program. Research and development is on the tightest schedule ever attempted for an ICBM.

An example of the manner in which the program is being pushed, BMD cites the silo development tests begun a little over a year ago. Within about six months, eight consecutive test missiles were launched and the program—which originally called for 18 test vehicles—was called completed. This was the first step in the four-part test program.

The flight-test phase—beginning at AMR with the Feb. 1 launch—will continue through a series of pad and silo launches.

The third phase will be the complete component compatibility checkout, involving all elements of the total weapon system. Also, during this phase, handling procedures at the Boeing-Seattle launch complex will be determined.

Fourth and final step in the program will be the demonstration of the operational system and training of AF crews at Vandenberg AFB. Firing of a test vehicle from a railroad launcher will probably occur within a year. The mobile system is scheduled for operational status in 1963.

• **Progress on bases**—Two fixed *Minuteman* bases are already in the planning stage. The first of these hardened sites will be near Malmstrom AFB, Great Falls, Mont. Deployment of the second wing—three squadrons—will be at Ellsworth AFB, S.D.

Award of the first construction contract is scheduled within the next few months. The original Malmstrom bids were rejected due to problems with the specified construction schedule. The schedule has been readjusted to accommodate winter construction in the rugged climate, and re-bids are due shortly. BMD officials say no changes have been made in base design and revised construction schedules will not affect present deployment target dates.

Feasibility studies are now being conducted in the vicinity of Pease AFB, Portsmouth, N. H., to determine whether that site is suitable for a projected third hardened base.

## Soviet reaction awaited . . .

# Samos II Big Triumph for U.S.

***Camera-carrying satellite replaces U-2 as major reconnaissance weapon; Air Force declines to discuss details of payload***

POINT ARGUELLO, CALIF.—An Air Force *Samos II* satellite capable of photographing any point on the earth's surface with high-resolution cameras is orbiting over the Soviet Union and the rest of the world this week.

Once again, a missile has replaced an aircraft: *Samos II* is designed to do a job previously carried out by the U-2. When fully developed, the sensitive cameras aboard *Samos* (Satellite and Missile Observation System) will be able to photograph Soviet missile bases and troop movements even by starlight.

Industry sources say the Eastman Kodak and Ansco camera system for *Samos* can take detailed photos of ground installations which equal what the human eye would see at 100 ft. These are developed aboard the satellite and relayed earthward by television on command.

The research and development model was launched Jan. 31 at 12:33 p.m. from this Navy space base near Vandenberg AFB. A little more than two hours after it rose from its ocean-side pad into an overcast sky, word came that the *Agena* second stage had fired successfully and placed the vehicle into a 300-mile polar orbit.

Success came on the second attempt. Last Oct. 11, *Samos I* failed to achieve orbit when a faulty umbilical disconnect damaged the second stage.

• **Secrecy on photos**—Air Force officers refused to list the photographic equipment in the 3 and ½-x-4-ft. payload section of *Samos II*. But it was made clear that the satellite would take photos and that means were available to "assess" the quality of these.

Ground stations in California, Hawaii and Alaska were in communication with the satellite.

The Air Force would not say whether this means actual transmission of the photographs to earth by *Samos I*, although this is of course a prime objective of the program.

There was no plan to recover a film capsule from *Samos II*, although this is expected later in the development stage with equipment being tested in the *Discoverer* program.

Although the Air Force would not confirm it, payload of *Samos II* was similar to that of *Samos I*, which carried in addition to test photographic equipment, instrumentation to measure cosmic rays, micrometeorites and the earth's electrical field.

Launch of an operation *Samos* is not expected before next year.

• **Limited details**—First stage of the vehicle is a modified Convair *Atlas* weighing 262,000 lbs. at lanuch. It is 77 ft. in height. Second stage is a 22-ft. Lockheed *Agena A*, with an 11,000-lb. launch weight.

The entire *Agena* vehicle is in a 95-min. orbit and was programed to tilt so that cameras in the nose section point constantly toward earth. An in-flight control system maintains this attitude.

Although *Samos II* is expected to remain in orbit at least a year, transmitters aboard the satellite are expected to operate for only 20 days. Another limiting factor in the experimental model will appear with exhaustion of the gas supply to the jets which maintain the nose-down attitude of the cigar-shaped vehicle.

Reluctance to give further details of the *Samos* payload is coupled with the question of Soviet reaction to the spy satellite. ⌗

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# Europeans Debate 'Space Club'

**by Anthony Vandyk**

STRASBOURG, FRANCE—Britain proposed last week that four nations share the major cost of a cooperative launch program which would put an all-European communications satellite into orbit by 1966.

Cost was estimated at approximately $200 million, spread over five years.

British delegates to the European Space Conference here suggested that the financing should be 25% British, 22% French, 18% German and 11% Italian. Other participants would contribute less than 5% each, with the major powers making up any shortages.

Initial reaction to the proposal was favorable. It had strong backing from France.

The $200-million program calls for nine major firings, the last three of which could put satellites into orbit in the fifth year. Launchings would begin 12 months after the program is started. Ten *Blue Streak* vehicles for the first stage already are undergoing testing at Woomera Missile Range, Australia.

Second stage of the launch vehicle would be French and the third stage "European."

Reports were confirmed that extensive assistance in *Blue Streak* development was provided de Havilland by Convair. The *Blue Streak* has the same diameter as the *Atlas* and the motors are modified Rocketdyne engines built by Rolls-Royce. The French are expected to design an entirely new second stage since the *Veronique* is not considered powerful enough.

The proposed launcher would put a 330-lb. satellite into an 8500-mile orbit, using high-energy fuel in the third stage.

The British are backing a communications satellite as offering the best possibility of a financial return on the program. Delegates from both France and Britain believe the communications satellite angle might move some governments to release funds they would be reluctant to authorize on a pure research program.

Other delegations present included Austria, Belgium, Denmark, Germany, Italy, Netherlands, Norway, Spain, Sweden and Switzerland. Canada, Ireland, Greece and Turkey sent observers.

Cost is expected to be a knotty problem the European nations will have to untangle before the space program gets underway. Initially the program will probably only call for the orbiting of small satellites in the 200-300-lb. category. After a three-year scientific program, satellites in the 1000-5000-lb. weight category might be launched into terrestrial orbit. ⌗

*In speech to Congress . . .*

# Kennedy Calls for Defense Beef-up

by James Baar

THE NAVY IS PLANNING to launch one *Polaris* submarine a month in line with an explicit—and implicit—go-ahead ordered by President Kennedy in his State of the Union message.

At the same time, the Army is increasingly optimistic that it will receive sizeable budget increases to build up its limited war punch.

However, all other service plans for boosting the nation's military strength are being held in abeyance while Defense Secretary McNamara and four special task forces conduct an overall review of U.S. defenses.

These plans include such big money proposals as a speed up of the *Minuteman* ICBM program, production of the *Nike-Zeus* antimissile missile and a full-scale military space program aimed at developing both defensive and offensive space systems.

Kennedy touched only lightly on space matters. He said the United States is "ahead in the science and technology of space while the Soviet Union is ahead in the capacity to lift large vehicles into orbit." And he added "these endeavors" should be removed from the Cold War.

"I now invite all nations including the Soviet Union to join with us in developing a weather prediction program, in a new satellite program and in preparation for probing the distant planets of Mars and Venus, probes which may someday unlock the deepest secrets of the universe."

Kennedy did not discuss such space projects as the *Samos* reconnaissance satellite or manned military space systems.

• **Reports coming**—The four task forces are expecetd to make preliminary reports about Feb. 20. These reports, in Kennedy's words, will reappraise the entire U.S. defense strategy in light of:

"—Our ability to fulfill our commitments

"—The effectiveness, vulnerability and dispersal of our strategic bases, forces and warning systems

"—The efficiency and economy of our operation and organization

"—The elimination of obsolete bases and installations

"—The adequacy, modernization and mobility of our present conventional and nuclear forces and weapons systems in the light of present and future dangers."

The reappraisal began immediatel after Kennedy took office Jan. 20. Th four task forces are headed by Penta gon Comptroller Charles P. Hitc (strategic weapons); Paul H. Nitze, As sistant Defense Secretary for Interna tional Security Affairs (U.S. commi ments and limited war requirements Defense R&E Director Herbert Yor (all weapons R&D); and Thomas D Morris, Assistant Defense Secretary fo Logistics (U.S. bases).

• **Bigger effort**—Kennedy said th studies are necessary because "lack o a consistent coherent military strategy the absence of basic assumptions abou our national requirements and the fault estimates and duplication arising fron interservice rivalries have all made i difficult to assess accurately how ade quate—or inadequate—our defense really are."

Kennedy nevertheless made clea that the nation must strengthen it "military tools." And he promised Con gress that once he received the tas force reports from McNamara that h would "recommend whatever legisla tive, budgetary or executive action i needed."

"We are moving into a period o

*(Continued on page 39)*



## Long Beach with Polaris

*SEABORNE POLARISES will be deployed aboard the nuclear powered Cruiser Long Beach—first of a possible fleet of Polaris cruisers. The Long Beach will carry eight Polaris and other missiles. She will be operational in late 1963.*

# Webb Surprised Choice to Head NASA

## *Widely experienced in administration*

NEW NASA CHIEF James E. Webb, a long-time business associate of Senate Space Committee Chairman Robert S. Kerr, has promised to divest himself of any possible conflict-of-interest stockholdings.

Among other interests, Webb holds a directorship in the McDonnell Aircraft Corp.—prime for NASA's *Mercury* man-in-space program.

Selection last week of the 54-year-old industrialist-attorney came as something of a surprise. He had not been mentioned as even a "dark horse" candidate for the post vacated by educator T. Keith Glennan. And Webb himself conceded that the appointment came about rather suddenly.

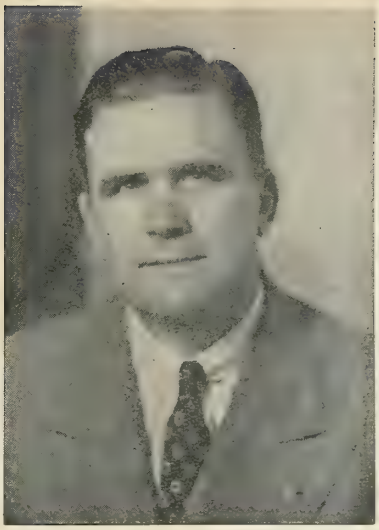
Hugh L. Dryden, deputy administrator under Glennan, will continue in the same capacity under the new administrator.

The delay in filling this major post in the Kennedy Administration apparently was caused partly by a behind-the-scenes disagreement between Kerr and Vice President Johnson and some of Kennedy's other advisers. Kerr and Johnson reportedly wanted a man with an industry background, while the opposition favored a man from scientific ranks.

There was also speculation that possible candidates had sidestepped the job because the future of NASA was still rather hazy. Although Kennedy has indicated he wants a space program to catch up with Russia, he has not made clear whether it should be undertaken by NASA or the military.

It is understood that Kennedy's scientific adviser, Dr. Jerome Wiesner, agreed to Webb as a compromise. Webb said Wiesner telephoned him in Oklahoma City on Jan. 27 to ask whether he was interested. Webb agreed, and the White House announced the appointment three days later.

• **Extensive background**—The new administrator told newsmen that he assumed he was chosen primarily for his administrative experience. He served three years as Director of the Budget Bureau and three years as Under Secretary of State during the Truman Administration.



*James E. Webb: President Kennedy's selection as the new NASA administrator.*

When he went to work for the government at that time, Webb said, he sold all his stocks and bought government bonds. He said he will again do whatever is necessary to avoid conflict of interest. His present connections also include an assignment as assistant to the president of Kerr-McGee Oil Industries Inc., of Oklahoma City—Sen. Kerr's company, and directorships in this and several firms.

He knows Wiesner well through work with the former MIT researcher in organizing Education Services Inc., of Watertown, Mass., which works to improve high school physics teaching. He is also chairman of the Municipal Manpower Commission and director of the Transportation Research Foundation of the Transportation Association of America.

Webb served on the Draper Committee which studied the U.S. military aid program in 1958-59 and on a special stockpile advisory committee to the Director of Defense Mobilization in 1957-58. He has been an occasional consultant to the National Security Council.

While serving as Budget Bureau director, Webb instituted organization of all government research activities in a special section of the budget. This step led to the study by the John Steelman committee that resulted in creation of the National Science Foundation.

Webb also is president of the Frontiers of Science Foundation of Oklahoma. While Under Secretary of State, he introduced the practice of assigning science attaches to major embassies. ⌗

# industry

**KELLOGG DIVISION** of American Brake Shoe Company has completed a three-month, 3000-mile move from Rochester, N.Y., to Oxnard, Calif. The move was made to consolidate the Division's activities nearer major aircraft and missile producers.

**YARDNEY ELECTRIC CORP.** has bought a 250,000-sq.-ft. plant from the Raytheon Company in Stonington, Conn. President Michel N. Yardney said the plant will be used to fulfill a substantial contract recently awarded by the U.S. Navy for submarine batteries and other contracts under negotiation.

**WESTINGHOUSE ELECTRIC** has completed its new semiconductor facility at Youngwood, Pa. The new 50,000-sq.-ft. building will be devoted primarily to the development and processing of semiconductor materials, including new forms of silicon and germanium. The company also has begun construction of its new Astroelectronics Laboratory near Los Angeles. The 25,000-sq.-ft. building will consist of an administration building and an adjoining laboratory.

**JACK & HEINTZ, INC.** has been merged into The Siegler Corp. through a stock exchange. J&H stockholders have the option of exchanging one share of J&H stock for 55/100 of a share of Siegler common stock, or accepting a $5.75 cumulative convertible series A preferred stock of Siegler at the rate of one share of preferred stock for seven shares of Jack & Heintz. No changes in Jack & Heintz management, employees or facilities are planned.

**ERA RESEARCH INC.** has been organized to manufacture and market new electronic devices for educational and commercial use. Nuclear physicist Harold Hutchinson of UCLA is president, and chief consultant is Dr. Kenneth MacKenzie, also of UCLA. The company has established executive and sales offices in New York City and Los Angeles.

**APPLIED ELECTRONICS CORP.** has sold a 40% interest in its former subsidiary International Communications Corp. to Electro-Science Investors of Dallas. The transaction was concluded for a reported $400,000. James J. Ling, also president of Ling-Temco Electronics, is chairman of the board of Electro-Science, a company specializing in small businesses investments.

# Government Sees New Record Electronics Output in 1961

RECORD ELECTRONIC equipment outputs of $6.8 billion are expected in 1961—surpassing the 1960 highwater mark estimated at $6.4 billion.

In its annual review of the electronics market, the U.S. Department of Commerce's Business and Defense Services Administration feels that the missile/space field will provide much of the stimulus so urgently needed to offset the effect of the current recession.

The electronics industry as a whole is possibly the fastest growing unit in the U.S. economy. Output in the past 25 years has expanded 27 times compared with 5.5 times in the gross national product.

Despite the current recession, total sales excluding RDT&E of $2 billion reached an all-time high in 1960 (equipment—$6.4 billion, components over $3 billion), BDSA asserts. Further predictions indicate the 1961 output will be even higher.

The Commerce report indicates—in no small measure—the prodding effect of the missile/space field. Not only is the missile/space market increasing, but its relative use of electronics is continuing to increase percentagewise. A secondary effect is the continuing demand by the missile/space industry for new components—miniaturized, rugged, more reliable, vastly more accurate.

Growth over 1959 was roughly 10%. Only electron tube sales failed to rise (down 2%) and this of course was more than offset by the steady increase in semiconductor sales. The trend should continue in 1961, but the spread between tubes and transistors should widen more and more, BDSA says.

• **Military electronics**—The 1960 output of military systems and equipment increased about 15%, not because of a great increase in units but to an everwidening use of electronics in weapon systems and associated complexes.

R&D for such systems, the report states, increased 10% over 1959 to about $1.8 billion.

The need for more advanced systems, the steadily expanding space programs, and the increasing dependence on electronics techniques will again bring an estimated 10% increase during 1961.

It is noted, however, that even if defense obligations are increased substantially by the new administration, the effect will hardly be felt until late 1961 or 1962 because of the long lead time required to contract and schedule production.

The complexion of the market has not changed, BDSA feels. It is still an R&D market with limited production. R&D expenditures are expected to level off in 1961 but increase again in 1962 as the need for more advanced weapon systems again comes into prominence. RDT&E should reach $2 billion in 1961.

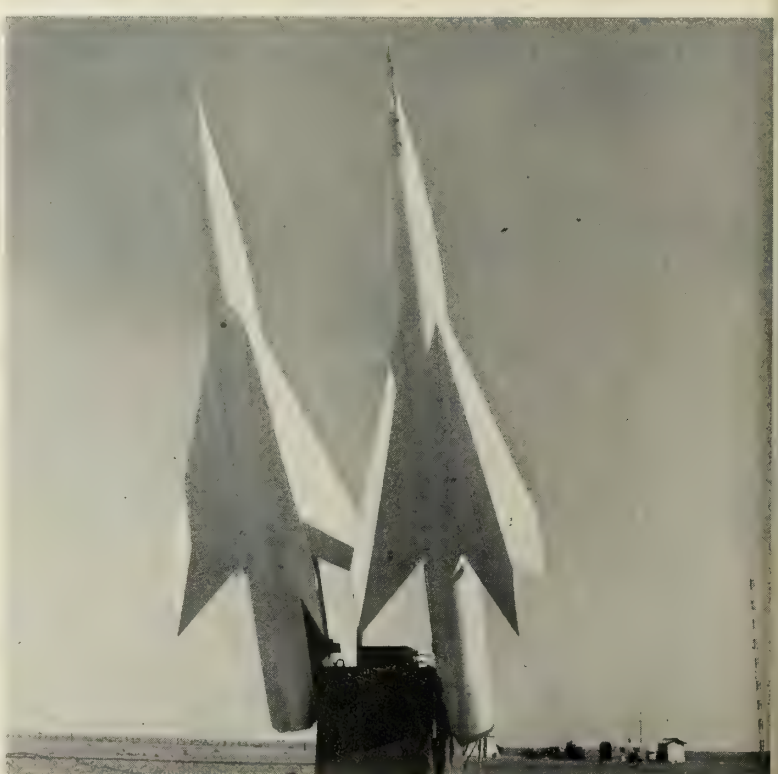
• **Commercial, industrial electronics**—Production increased in this area also by about 10% during 1960. The driving force here is believed due largely to greater capital expenditures for electronics equipment to reduce operating costs and increase efficiency. At the same time, considerable equipment was needed to support the increasing military production and RDT&E programs.

• **Other electronics**—Electron tube shipments dropped 2% during 1960. Replacement sales represent half the total and served to stabilize the market. Tube output in 1961 is expected to remain about the same as 1960, according to BDSA.

Semiconductor sales increased by 35% in 1960. Transistors amounted to $313 million; other semiconductor components reached $222 million. The dollar rise did not correspond to the unit total increase because of substantial price reductions throughout this industry segment. Estimated 1961 sales will show another marked increase—$610 million total compared with the $535 million in 1960.

Other electronic components showed about a 10% increase in sales during 1960. An increase of about 5% is predicted by the agency in 1961, reaching a total of $2 billion.

The switch to automation and modular construction at the factory plus increasing use of new techniques (such as thin-film) will have a decided effect on the overall market. ⁂



**Bullpup Competitor**

*NORD-AVIATION reportedly has evolved an air-to-surface missile with this configuration. Called AS-30, it has Hughes guidance, is said to be cheaper than Bullpup.*



**BURIED BUT ALIVE**

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# Technical Countdown

## ASTRONAUTICS

### Balloon-Satellite Data Updated

*Echo I* orbital changes indicate an average atmospheric density of 1.1 x $10^{-18}$ g/cm at an altitude of 940 miles (with an uncertainty of a factor of 2). Allowing for orbital distortions caused by solar radiation pressure, the balloon satellite now has an estimated life of 1-2 years. Without solar radiation effects, the satellite would remain aloft about 20 years.

### Weightlessness Small Problem to Soviets?

Soviet biomedics apparently feel that weightlessness is a minor problem, if a problem at all, in space flight. Their published comments on the subject reflect concern only with the psychological adjustment for the astronaut, rather than any difficulties in carrying out missions, consuming foods, or moving about in space vehicles. To help defeat radiation hazards, Russian chemists are working on a protective agent containing sulfur, albumens, vitamins, and hormones, which—when introduced into the body—is expected to increase resistance against radiation.

## ELECTRONICS

### Duoplasmatron Produces 1-amp Ion Beam

A duoplasmatron has been developed at the East German facility of Forschungs-institut Manfred von Ardenne, Dresden-Weisser Hirsch, capable of producing an ion beam of 1 ampere. A current discharge of 5 amperes with 60% proton content can be obtained, the East Germans say. In pulse operation, discharge currents from 20 to 100 amps can be obtained, with 85% proton content. Researchers claim that the device's efficiency in gas consumption and ion component of the drain current is almost 100%.

### Superconducting Tunneling Diode Developed

A newly discovered tunneling effect—using two metal films separated by a thin insulating layer, with one or both the metal films in a super-conducting state—has been revealed by General Electric scientists. Tunneling occurs through the insulating film barrier—rather than through the charge depletion region of a semiconductor p-n junction, as in a tunnel diode.

### More on Fiber Optics

American Optical has just received a large research contract from WADD to study methods for improving quality of fused fiber-optics face plates and to develop better manufacturing techniques. The plates are used in cathode ray tubes for high-speed recording of data from computers and radar receivers and in image converters. The job also includes advanced work on tapered fiber bundles for use in "ultra-high-speed photographic lens," also being developed by AO for Air Force.

## PROPULSION

### Freon Considered for A3 Vector Control

*Polaris A3* model probably will use a freon-gas system for thrust vector control, eliminating the jetavators now used. Because the jetavators cause some obstruction of the exhaust stream, the Navy would like to eliminate them. Freon gas injected into the nozzle from selected points would serve the same purpose with improved efficiency.

### JATO Bottles Re-used in Rocket Cases

Rocketdyne-McGregor is welding together used JATO rocket cases to save money in producing development cases for the Army *Roadrunner* target-missile booster. One full case and 11 inches from a second case make a case for the *Roadrunner* rocket, which produces 5500 lbs. thrust for about five seconds. The propellant is an advanced form of the ammonium nitrate propellant used in *M-34* boosters and the *KD2U* target drone. Rocketdyne reports development of the rocket is ahead of schedule. North American's Columbus Division is prime contractor.

## ADVANCED MATERIALS

### Tantalum Production Increases

National Research Corp. boosted its tantalum production capacity by 33%. The expansion resulted from increased demands for tantalum in the electronic and missile/space markets.

### Concrete High-Temperature Limit Raised

The Russians report that they have developed a concrete capable of withstanding temperatures up to 1700°C. They say this is several hundred degrees higher than any previously known concrete could resist.

### Al-Alloy Castings Approach 50,000 psi.

Investment casting methods at Precision Metalsmiths, Inc., are resulting in products of 355 aluminum alloy in the T7 condition with tensile strengths of 49,500 psi. The pieces have an elongation of 3% per 1 in. gage length. Typical tensile is 45,000 with a 4% elongation.

## SUPPORT EQUIPMENT

### Seaborne Launch Pad Proposed

PROP (Planetary Rocket Ocean Platform) has been proposed by Aerojet-General as a mobile site to launch nuclear rockets into trajectories or orbits which are difficult or impossible to achieve, from continental U.S. locations. Approximately 450 feet in diameter, the floating pad would be supported by an underwater buoyant chamber for below-the-surface effects of heavy waves in the open sea.

## ASW ENGINEERING

### Reds Mass-Produce Underwater Detectors

The Soviets have developed a small self-recording ultrasonic sounding device "for detection and delineation of underwater objects." The instrument has depth ranges of 0-45, -100, -150, and -450 meters. By employing phasing, the Soviets say, individual layers of water 50 meters thick can be inspected in the 0-300 meter depth range. The under-150-lb. device operates with a 24-v, DC input. Although they are now in mass production, there is no indication as to how many of the devices will be used, or where.

# New Satellite Configuration Studied

## *Cubic carrier scheduled for use in Transit firing*
## *Would offer advantages for Army's precision mapping program*

SAN DIEGO, CALIF.—Cubic Corp. is studying a new satellite configuration capable of carrying the transponder for the Army *SECOR* precision long-range mapping system into orbit.

A *Scout* vehicle would boost the new carrier. A mockup of the proposed satellite has been constructed by Cubic from a *Vanguard* shell. (cover)

At present, *SECOR* is scheduled only aboard the Navy's *Transit III-B* to be placed in a 500-mi. orbit by a *Thor-Ablestar*. Equipment is being delivered to the Army next month for the *Transit* shot.

But Cubic engineers say *SECOR* (Sequential Collation of Range) would gain several advantages from operation in its own satellite:

–Launching dates could be timed to meet the requirements of the system.

–Orbital inclination and orbital altitude could be selected as desired.

–Lighter weight and smaller satellites could be employed, reducing cost of the program.

The new satellite mockup seen on the cover is being used to study the weight and balance problems of the spaceborne portion of the system.

•**Three known points**—The *SECOR* system was developed for the Army Map Service, Corps of Engineers, primarily for the purpose of tying the coordinate systems of the various continents together accurately. It employs ground stations equipped with advanced distance-measuring equipment (DME) to measure range, on a time-shared basis, to a satellite.

When the system goes into operation with the *Transit* launch, four ground stations will be employed. Three of these will be located at known points in relation to one another. From range and time measurements, it will be possible to determine the unknown position of the fourth station.

The position of this fourth station is found by measuring its range to the satellite at several accurately known points on the satellite's orbit, as determined by the other three stations.

Cubic says the system will operate either when all four stations are tracking at the same time or when the fourth station is incapable of simultaneous tracking. In the latter case, an ephemeris is computed from the data obtained by the three prime stations.

Later, as many as six or eight stations may be employed together with additional satellites.

The first *SECOR* network will be in the Caribbean, with three of the four stations in adjoining countries—Costa Rica, Honduras and Columbia—and the fourth on the island of Jamaica.

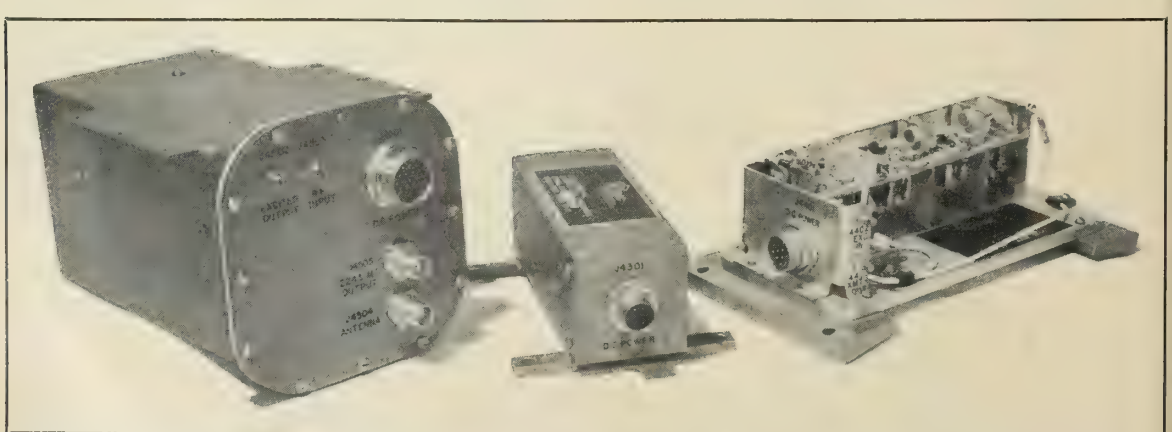
Cubic engineers say *SECOR* will make it possible to determine the position of the unknown station within a circle 10 meters in diameter. Although neither Cubic nor the Army will comment, such precise determination of positions on the earth's surface would provide valuable targeting information for the nation's ICBM's.

Each ground station will be made up of a directional antenna and two large helicopter-transportable shelters packed with electronic gear. Each shelter is labeled "Project Betty, Dept. of Geodesy." Detachable air conditioning and generator units are included.

The directional antenna in order to handle wide band is designed to geometric rather than electronic proportions. Its four baskets give it the look of old-fashioned sound locators.

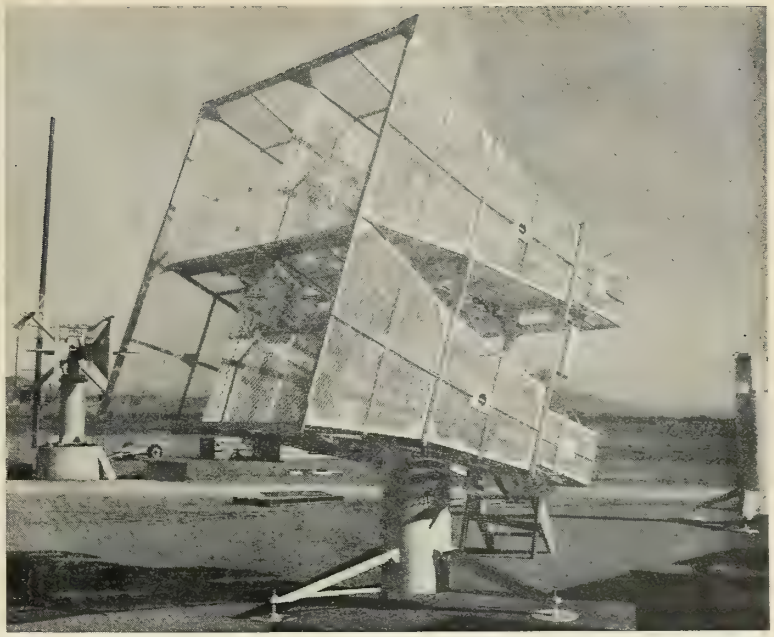
Three frequencies are employed—421 megacycles outgoing with return at 449 and 224½ megacycles. Two return frequencies are employed to correct for ionospheric refraction.

Spaceborne portion of the system consists of a 7-lb., 12-oz. transponder, containing a receiver, tone decoder, data filters, power converter and an exciter for the final power amplifier. The unit is mostly transistorized, with the exception of three General Electric ceramic tubes. At the time *SECOR* was laid out, it was not possible to transistorize the unit competely at the frequencies employed.



*GEODETIC SECOR transponder and power package put together by Cubic Corp. includes a receiver, tone decoder, data filters, power converter and exciter for the final power amplifier. The unit is highly transistorized.*

# For SECOR



*SIDE VIEW OF Geodetic SECOR antenna and pedestal at Cubic plant. Each ground station in the system will include antenna and two shelters for electronics.*

Power aboard *Transit III-B* is supplied by the satellite's 12-volt battery.

The transponder unit aboard *Transit III-B* is carried in three packages—one, a low heat generator, inside the satellite, and the others externally beneath the solar cell belt.

Cubic has built five transponders for the present program, three for launching, one for systems checkout at Applied Physics Laboratory, and the fifth to remain in San Diego for test purposes. In calibration tests before delivery to the Army, a transponder is being flown in a Navy TV2 aircraft for operation with four ground stations situated in Southern California.

The system eventually will employ several satellites in orbit with transponders aboard. Project *ANNA*, the joint geodetic satellite, is scheduled to carry one. Selective call is provided so individual satellites can be contacted.

The air-transportable boxes making up the shelters for the *SECOR* ground station are built by York-Hoover Corp. One contains a receiver unit, high- and low-voltage power supplies, an antenna control box and the low-power end of the transmitter. The high-power portion is on the antenna.

The data-handling shelter contains three Brush Instrument recorders of two channels each with range variation and ionospheric correction. Another cabinet contains the signal receiver and equipment for making digital phase measurements.

Primary method of data handling is with magnetic tape using a digital format. Equipment used is supplied by Potter Instrument Co. Tapes from each station are sent to the Army Map Service, where they will be fed to a Minneapolis-Honeywell 800 computer.

Each ground station establishes its distance from the satellite by transmitting a frequency-modulated, continuous-wave signal which is received and rebroadcast by the transponder. During transmission the ground station records the phase shift between its transmitted signals and those received from the transponder.

The ground stations interrogate the transponder, in sequence, for 12½ milliseconds apiece with dynamic smoothing to provide the equivalent of simultaneous sightings.

An Instrument Corp. of Florida digital clock provides real time measurement within the nearest millisecond. Any station in the system can act as either master or slave. By detecting the master identification signal, other stations can set up a fixed time reference in relation to the master station.

No satellite acquisition problems are anticipated with *SECOR*. Wide-beam antennas make acquisition relatively simple, with only time and azimuth needed from the launch crew. Range of the system is given as 10,000 mi. ⌗

## Host of Firms Show Interest in NASA's Relay

FORTY-ONE COMPANIES are interested in bidding on the Project *Relay* communications satellite for the National Aeronautics and Space Administration.

NASA originally invited 20 companies to its briefing on the contract, originally scheduled by the Goddard Space Flight Center, Greenbelt, Md., for Jan. 4 and 5 (M/R, Jan. 9, p. 13).

However, many others asked to be represented and 41 appeared at the briefing Jan. 24 and 25. The full list follows:

AT&T, General Electric Missile and Space Vehicles Division, Lockheed Missiles and Space Division, Philco Western Development Laboratories, Ford Aeronutronic Division, Republic Aviation, Avco Research and Advanced Development Division, Western Electric Radio Division, IT&T Federal Division, IT&T Kellogg Division, Bendix Systems Division, Hughes Aircraft, Motorola Western Military Center, RCA Astro-Electronic Products Division, The Martin Co., Collins Radio, General Dynamics Convair Division, Page Communications Division of Northrop, North American Missile Division.

Also, Grumman, McDonnell, Loral Electronics, General Dynamics' Stromberg-Carlson Division, General Telephone & Electronics, Melpar, Sperry Gyroscope, Telechrome Manufacturing, H. R. B. Singer Inc., Watkins-Johnson, Northrop Radioplane Division, Raytheon Aerospace Division, Airborne Instruments Laboratory, Dumont Military Electronics, Hoffman Electronics, IBM, W. L. Maxson, Minneapolis-Honeywell, Space Electronics Corp., Electronic Communications, Lyons Transdata and STL.

Bids are due by March 6.

## NASA to Set up Staff For Theoretical Research

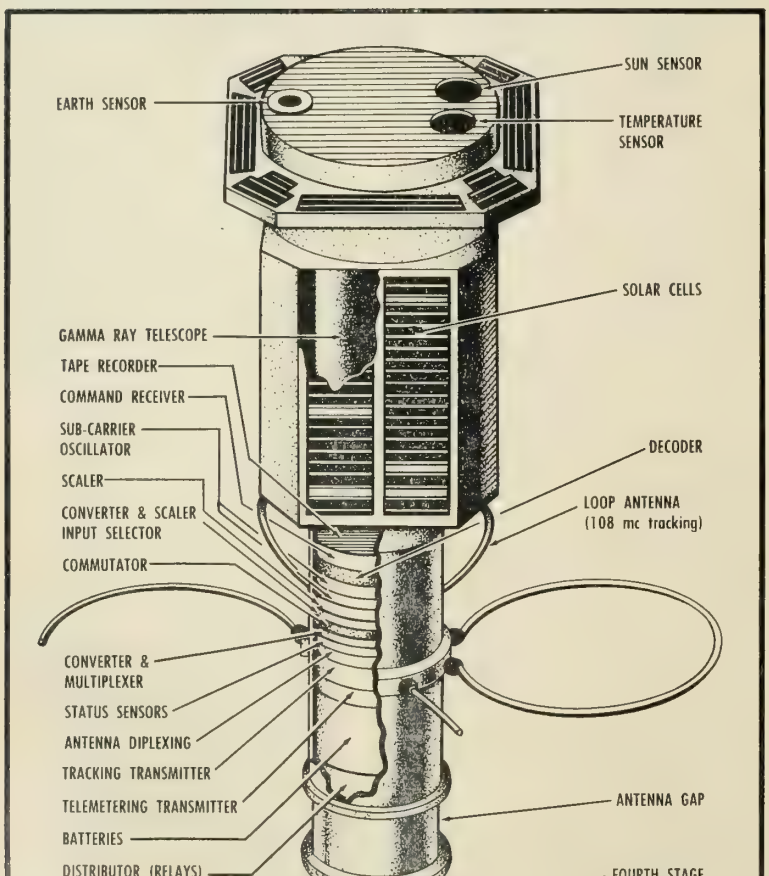
THE NATIONAL AERONAUTICS and Space Administration will establish a group of about 50 scientists and supporting staff in New York City to conduct theoretical research in astronomy and space sciences.

The office site has not been chosen. ⌗

# S-15 May Solve Cosmic Ray Riddle

***NASA shot due by March 31 will use gamma-ray telescope to search below inner Van Allen belt; MIT, Raymond Engineering Lab involved in "most complicated" test***

**by William Beller**




*CUTAWAY DRAWING of 85-lb. gamma-ray payload, showing circular strut assembly that fits into third stage of Juno II, the cross-loop antenna for tracking and reciving, and the solar-cell assembly encasing the payload.*

A MAJOR STEP in astronomy-from-a-space-platform is planned before the end of March—a search of the sky with a gamma-ray telescope orbiting below the inner Van Allen belt.

Gamma rays, like X-rays and light rays, are electromagnetic radiations. Their frequencies correspond to very-high-frequency X-rays.

Results of this experiment could answer the 60-year-old question of where cosmic rays come from. A lesser but still formidable ambition is to get a gamma-ray map of the sky. The experiment is said to be the most complicated ever tried in a satellite.

As with cosmic rays, nobody knows where the sky's gamma rays come from. The chief surmise is that they result from the interaction of cosmic rays with galactic gas. Hence for the time being they are termed "galactic secondaries," analgous to the cosmic ray secondaries formed when cosmic rays impinge on atoms of the earth's atmosphere.

• **Inside the payload package**—A *Juno II* space vehicle will put the 85-lb.-gamma-ray payload—*"S-15* satellite" is the National Aeronautics and Space Agency's designation—into a hoped-for circular orbit. The payload is built onto the spin-stabilized fourth stage of the *June II* system.

Nickel-cadmium batteries recharged by solar cells will be giving electrical power to the payload. The satellite's scientific life is expected to be one year.

Similar to the *Explorer* series of satellites, the *S-15* is a two-antenna system. The cross-loops are for tracking and command receiving. The split dipole—divided by the antenna gap on the fourth-stage rocket—is for data transmission only.

The *Vanguard*-satellite type construction is used for the instrumentation column. Thus, foam-podded, 6-in.-diameter cylindrical pies—each one serving a different housekeeping or electronics function—are stacked one on top of another like checkers. The system can be assembled as easily and be as reliable as any modular structure.

The gamma-ray telescope is a scintillator plus a Cerenkov counter; and these are in coincidence to detect the gamma rays and also to reject spurious events.

The telescope has a broad field of view of about a 30° solid angle. It can

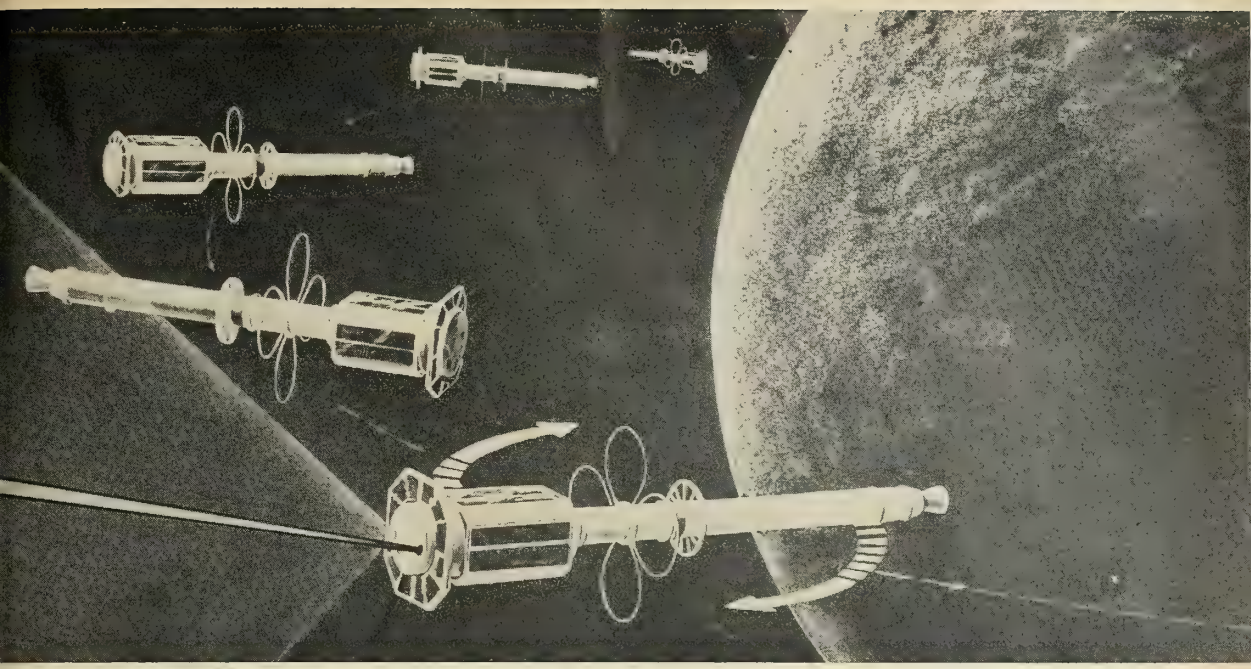


*DIAGRAM SHOWS TRAJECTORY of gamma-ray payload about its maximum-moment-of-inertia axis at about 10 rpm.*

measure gamma rays with energies of 100-million electron-volts and up. Most of the ray energies are expected to fall between 100-million and 400-million electron-volts.

This gamma-ray work is a Massachusetts Institute of Technology experiment funded by NASA. Principal MIT investigators are Professor of physics William Kraushaar and Associate Professor of physics George Clark.

The Marshall Space Flight Center in Huntsville, Ala., designed the payload except for the telescope, which is an MIT design and the tape recorder, which is the design of Raymond Engineering Laboratory, Middletown, Conn., and Goddard Space Flight Center, Beltsville, Md.

Marshall is also doing the payload integration and testing, and will be responsible for the launching.

Goddard will be tracking the *S-15*, acquiring the data and reducing them. Subsequently, the MIT investigators will analyze the information.

Other companies involved include the Electronics and Ordnance Div. of Avco, which made the command receiver; and Texas Instruments, which built the commutator and the converter and multiplexer.

• **Almost an impossible project**—About a year and a half ago the chances of sending up the gamma-ray telescope looked dim from a technical standpoint. Here's why: the spin-stabilized upper stage of the *Juno II* was designed to rotate at about 400 rpm. For telescopic observations, this was far too fast. In addition, the forces induced by this speed were too high for the relatively delicate instrument to resist for long.

There were thoughts of using reaction jets or some other such control measure to slow down the rotation. These were looked upon with little enthusiasm because of the design and reliability problems they would bring with them.

At this point, Marshall scientist Dr. Charles A. Lundquist made a brilliant observation and thereby solved the problem. He said that because of the inherent instability of the rocket stage rotating about its thrust (minimum moment of inertia) axis, the rocket would eventually rotate about its axis of maximum moment of inertia with a consequent despin.

In this way, Lundquist indicated that nature would accomplish for the designers what they were contemplating doing mechanically. The spin rate would eventually be reduced by the transfer of momentum from the minimum-moment-of-inertia axis to the maximum-moment-of-inertia axis.

For the *S-15*, the ratio of the two moments of inertia is about 40. Therefore, the 400-rpm rotation about the thrust axis is reduced to 10 rpm about the maximum-moment-of-inertia axis, which is a tolerable design value for the telescope.

Also, 10 rpm now becomes the rate at which the telescope will scan the heavens. This means that once every six seconds the telescope will make a complete transit of the sky.

• **Getting a fix on the** *S-15*—In one very important instance the *S-15* is unique. Its orientation with respect to the celestial sphere will be known at all times. Presently, a satellite's position is known only as an angle with respect to the sun.

The orientation method was devised by Goddard's Dr. James E. Kupperian, Jr., head of the astrophysics branch. It involves two sensors. One is a relatively insensitive one for the sun; its field of view is large, 170°. The other is a relatively sensitive sensor for the earth; its field of view is only 15°.

From the combined outputs of these sensors, a computer can calculate the orientation of the satellite's spin axis to an accuracy of about five degrees.

The orientation of the spin axis will change slowly. It will change under the effects of solar radiation pressure, the earth's magnetic field, atmospheric drag and gravitational torque.

Ideally, the experimenters want a circular orbit below the Van Allen belt for their satellite. The Van Allen belt if penetrated would contribute only background noise that would have to be rejected, maybe to the failure of the experiment.

Kupperian points out that this is the beginning of gamma-ray astronomy in space. ⌗

# Price of Inadequate Measurement Standards

***AIA-sponsored conferences find that lack is hurting defense effort; NBS moves to increase services***

CONFUSION, EXCESSIVE delays and loss of money are the penalties both industry and national defense are paying for a lack of national measurement standards adequate to the Missile/Space Age.

This is the conclusion reached by a series of measurement research conferences conducted by the Aerospace Industries Association's Quality Control Committee, with the cooperation of the National Bureau of Standards.

These conferences, by providing a forum for exchange of ideas, have brought about a better understanding of the limitations under which measurement experts operate both in industry and at NBS. In some cases, the Bureau decided after the talks to make some program changes; these will soon result in additional calibration services.

More meetings are planned. The next series, to be held at the NBS Boulder (Colo.) Laboratories, will deal with radio frequency measurement problems. A series of meetings on shock, vibration, force, and acceleration is tentatively scheduled for April. Other areas are due to be covered during the summer.

• **Microwave power and attenuation**—The first two meetings, held at Boulder in May, 1960, dealt with microwave power and attenuation measurements. Underlining needs in this area, an industry representative described million-dollar development of radomes which had to proceed more by trial and error than by test and analysis, because there are no precise phase and amplitude measurement capabilities in the required frequency range.

Another conferee cited the practice of over-designing Klystron tubes—devices used to generate high-power signals for radar detection systems—to insure that the tubes are powerful enough to do the job. Techniques for accurate measurements of peak microwave power would make this costly procedure unnecessary.

For these and some of the other needs it discussed, the meeting saw no immediate solutions. In other cases, however, interim solutions were suggested and are being adopted. For example, calibration, services for waveguide power measurements in the frequency range 3.95-8.2 gc and coaxial power measurements in the frequency range 300 mc to 12.4 gc will soon be made available at NBS—although these will be somewhat less accurate than will ultimately be necessary.

• **Internal diameters and surface finish**—The second group of meetings, at the Bureau's Washington laboratories last June, was devoted to problems faced by industry in measuring internal diameters and surface flatness and finish.

The miniaturization imposed by space limitations in missiles and aircraft has caused a reduction in hole sizes, and the resulting calibration demands are in ranges lower than NBS can presently handle.

During these meetings it also became evident that inertial guidance systems—and such developments as the use of gas bearings—have created requirements for extremely close tolerances. One industry representative contended that if there were measuring techniques to permit holding the tolerances on bores and bearings to 10 microinches, the cost of a large-quantity production item could be reduced from $950 to $250. In the case of another item, because of inadequate accuracy in measuring hole sizes, three $25,000 units must be constructed for every good one produced.

At this meeting, the industry representatives made a strong plea, for a research effort at NBS looking toward development of standards and measuring techniques based, if possible, on entirely new concepts—since old methods cannot provide the ultra-precise gaging necessary to the interchangeability of parts so essential in modern industry. At present, industry is being forced back into the medieval concept of hand-craftsmanship.

During the discussion of surface finish measurements, the problem of noisy gyroscopes was cited. This type of faulty operation is believed to be



*EXPERIMENTAL tantalum tube high-temperature furnace is used to calibrate refractory metal thermocouples at temperatures above 2000°C. Lack of standards for extremely high temperature measurements is a critical problem in space technology.*

associated with surface finish characteristics, since changing bearings or other frictional surfaces usually corrects the difficulty. With existing standards and techniques it is not possible to measure surface characteristics accurately enough to eliminate defective components prior to assembly.

Such trial-and-error methods are extremely costly in time and money.

As a partial solution to this problem, the Bureau plans to offer a calibration service for physical roughness standards, although the initially available accuracy probably will not meet all needs.

• **Gears**—The fifth meeting, in September, covered the problem of gear calibrations and measurements. Limitations in the use of master gears as standards were recognized; but this appears to be the only technique presently available for small gears. Industry representatives urged that NBS acquire the facility to provide a calibration service for such gears, and simultaneously organize a strong research program to develop better methods for standardizing gear measurements.

One industrial representative reported that in the first six months of 1960 the cost of gears rejected by his company exceeded $54,000. This was the direct result of the absence of standard gear masters. In addition to these obvious losses, the company, because the high rejection rates resulted in sporadic deliveries, was forced to work its production facilities overtime at premium pay to fill orders.

• **Infrared, temperature and humidity**—The most recent series of meetings, last October, dealt with these measurements.

The need for specification of a "standard wet atmosphere" as a basis for evaluating the performance of infrared systems was stressed by several industry representatives. Attempts to get agreement between users and suppliers of infrared equipment have run into serious difficulties because of the lack of agreement on test conditions. It was urged that the Bureau's current work in determining the molecular absorption properties of atmospheric constituents be continued at a high level as an effective contribution in this area.

Programs in which radiometric measurements and decisions based on them must be made from satellites were cited as costly undertakings, the success of which is being periled by the lack of sufficiently accurate measurements and standards. Conferees observed that several military systems are operating with less than desirable reliability because decision-making functions are based on infrared measurements of inadequate accuracy.

Although the NBS program in temperature measurements and standards has nearly doubled in the last five years, it still is inadequate, industry members charged. In cryogenics, extensive industrial use is being made of superconducting circuits and of cryogenic inertial reference systems. Temperature measurements with ever-increasing accuracy are required.

Exemplifying measurement problems in the intermediate temperature range, an industry representative said, is the necessity for precise temperature control within gyroscopes used in certain inertial reference systems. The system accuracy is strongly affected by the accuracy with which the temperature sensing and controlling elements function to maintain uniform performance of the gyroscope.

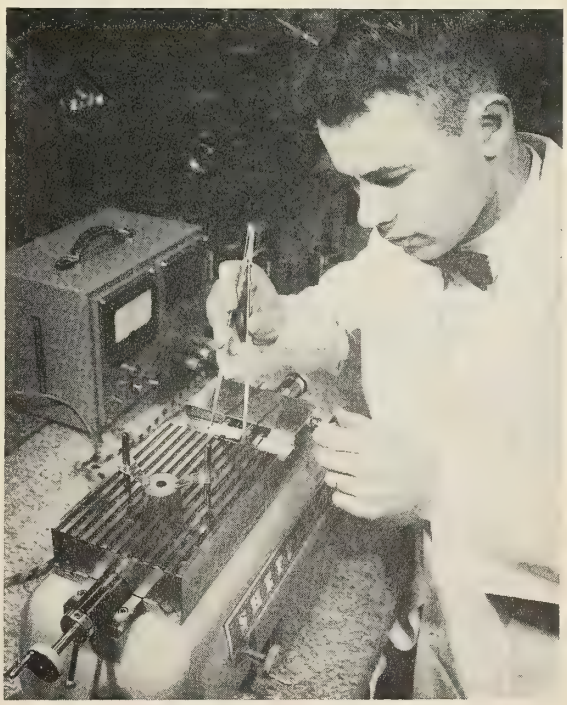
In the very-high-temperature region more accurate measurements are needed in the study of materials suitable for rocket throat lining. Rocket design engineers feel that they are badly handicapped in their efforts to improve the design of rocket motors because standards and techniques for the measurement of exhaust gas temperatures are essentially non-existent.

The costs of improper design in this area are large. For example, the cost of fuel alone in a single test firing of a certain rocket was given as $125,000. The fact that even a small reduction in measurement uncertainties would reduce the number of test firings was repeatedly stressed.

One industry representative described an abort maneuver navigational system, for a glide-type re-entry vehicle, based on temperature measurements. He reported to the group that while the proposed technique appeared very attractive from every other consideration, it had to be abandoned—at the cost of increased complexity and reduced reliability—because temperature measurements could not be made accurately enough.

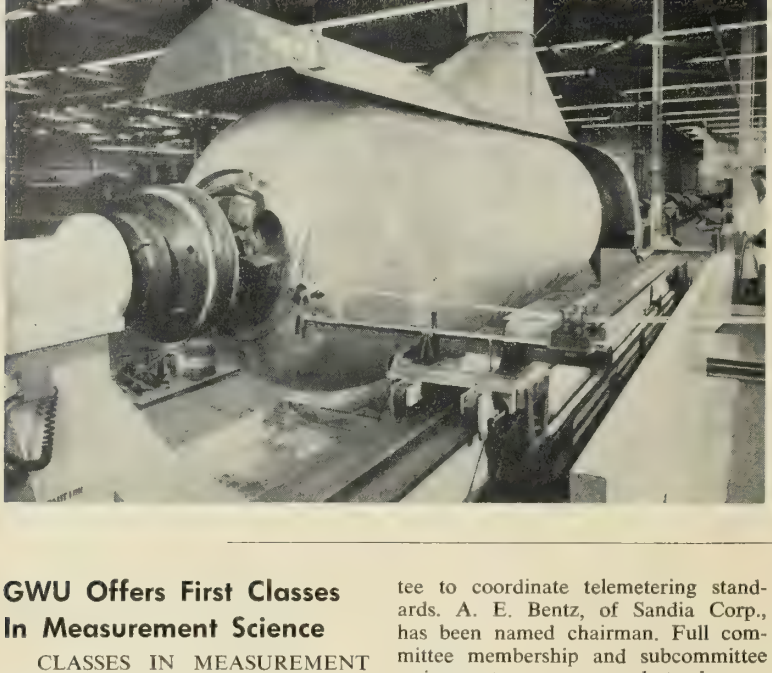
It was pointed out that, in many applications, not having sufficiently accurate temperature measuring techniques actually costs far more in terms of months before checkout than in terms of dollars, although it is seldom possible to arrive at a definite estimate of the time factor.

The meeting heard two examples of how weight in a missile system was reduced through a limited increase in the accuracy of temperature measurements. In one case, reduction of the uncertainty from 10° to 2°F effected a savings of 250 lbs. with a substantial improvement in range. In the other, it was demonstrated that improved temperature measurements available for determining the thermal conductivity of a heat shield would permit saving 125 lbs. in the payload, which was translated into 12,500 lbs. in the complete system. Although accurate data on cost per pound for such a system were not available, possible savings were estimated at many thousand of dollars. ⌗



*PLAIN CYLINDRICAL ring gage is measured with commercial machine that checks inside diameters of holes as small as .017 in. with accuracy of a few millionths of an inch. Lack of suitable ID measurement techniques is a major difficulty in production of precise devices.*

## Boeing Experiments With Glass Fiber Tanks



DUAL COMPARTMENT liquid fuel tanks are being wound from glass fiber filaments at Boeing Airplane Co. The experimental development is being conducted under a $100,000 contract from the Air Research and Development Command.

The tanks measure 6 ft. in diameter and 21 ft. in length. Each holds 3100 gallons and is designed to withstand a pressure of 665 psi. The vessels are lined with a special aluminum foil and plastic sheeting developed by Boeing. This liner prevents rocket fuel from dissolving the bonding agents used in forming the filaments.

The dual compartments are for fuel and oxidizer. The rocket engine with which such tanks could be used was not identified. Boeing is also considering ceramics as materials for the winding process. Principal advantages of the process are in cost and weight reduction.

## GWU Offers First Classes In Measurement Science

CLASSES IN MEASUREMENT science, the first offered in this country, begin this week at George Washing University in Washington, D.C., mark a growing recognition of the importance of metrology in the missile/space industry.

The National Bureau of Standards will provide all laboratory facilities for the classes until GW can equip its own facilities.

Part of the expenses of the Center for Measurement Science will be borne by "associates" — individuals, firms, government agencies—who contribute $5000 annually to the Center. In return, the Center will provide the associates certain privileges including consultation and technical service on their measurement problems. Martin-Baltimore has already become an associate; Aerojet-General and Weinschel Engineering have expressed interest in the program and the latter is supplying an instructor. One large machine manufacturer is contemplating a substantial gift of equipment.

Acting secretary of the Center is W. J. Mayo-Wells, assistant professor of electrical engineering at GW. ⌗

## Telemetering Group Shapes Committee on Standards

THE NATIONAL TELEMETERING Conference has completed the groundwork in its organization of a long-sought and badly needed committee to coordinate telemetering standards. A. E. Bentz, of Sandia Corp., has been named chairman. Full committee membership and subcommittee assignments are expected to be announced soon.

Memberships will include technical representatives from the four groups involved in telemetering: missile ranges, missile manufacturers, telemetering equipment manufacturers, and government agencies. There will be seven members from industry, seven from government and one representative from each of the engineering societies included in NTC (IRE, ISA, IAS, ARS, and AIEE).

The committee will serve as a focal point for reception, coordination and dissemination of information and will recommend and endorse standards, methods, and procedures to users, manufacturers and supporting agencies. Specifically, the group will determine what telemetering standards are in existence and planned, their technical adequacy, and the need for additional standards. It will also establish such new standards as are needed. ⌗

## AF Seeks Fiber to Replace Nylon in Some Space Roles

THE AIR FORCE is searching for a fiber to replace nylon for use in decelerators, manned satellites and space suits.

Nylon's low melting point, 484°F, eliminates it from certain space applications where temperatures in the order of 2500°F are expected.

Scientists at the Air Research and Development Command are investigating fibers made of gold-plated tungsten and molybdenum, glass, ceramics, super alloys and other materials.

The fibers are developed by contractors from industry and sent to ARDC's Wright Air Development Division, Dayton, Ohio, for evaluation. Properties such as tensile strength, stretchability and energy absorption are high on the list.

One basic problem lies in achieving fine diameters—0.0002 mil across. Since resilience increases as the diameter decreases, the finer the better. Fibers of this type can be twisted together to give any cloth woven from them resilience, flexibility and tear strength.

## LMSD Uses Mylar for Experimental Antennas

LIGHTWEIGHT ANTENNAS fabricated from clear Mylar film and Mylar-reinforced aluminum foil inflatable from compact packages are under development at Lockheed Missiles and Space Division.

The experimental antennas were fashioned for the Air Force's Wright Air Development Division specifically for space applications.

Designs include a six-foot sphere, a conical spire, the log-periodic and fan beam. The first is highly directive for point-to-point communication. The spire and log forms are designed for wide coverage of the globe and the fan beam is a compromise between the wide and narrow beam.



**Said Gaspard de Coriolis:** *"A particle which is subject to no forces in a rotating coordinate system experiences a radial acceleration and a tangential acceleration."*

It was around 1840 that Coriolis discovered what has since become known as the Coriolis Effect. He noticed objects above the earth tend to rotate relative to the earth's rotation . . . to the right in the northern hemisphere, to the left in the southern.

The Coriolis Effect is in force in outer space, too. If a space vehicle is rotated in order to establish artificial gravity, the necessarily short radius of the rotation causes a Coriolis force. This creates orientation problems for a human occupant. To eliminate this difficulty, a scientist at Lockheed Missiles and Space Division conceived the idea of connecting the vehicle to an auxiliary fuel tank by a half-mile-long cable. Thus, if the whole system is then rotated at a reduced speed around its center of mass gravity, the longer radius greatly minimizes the Coriolis force. Right now—on the drawing boards at Lockheed—is an enormously advanced space vehicle system which utilizes this concept, in addition to many others.

Fortunately, natural laws are about the only restrictions which circumscribe scientists and engineers at Lockheed Missiles and Space Division. The climate in Sunnyvale and Palo Alto, on the San Francisco Peninsula, is close to perfection. The creative atmosphere—the opportunity to work on such important projects as the DISCOVERER and MIDAS satellites, the POLARIS FBM, or even more advanced concepts such as the space system cited above—is the dream of the creative engineer.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-11A, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

**Lockheed** / **MISSILES AND SPACE DIVISION**

*Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs*

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

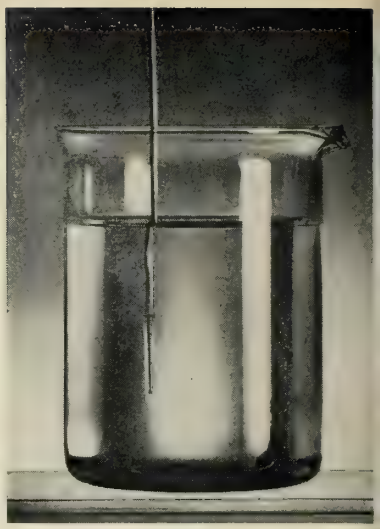
# Special Gages Will Record Strain on Dyna-Soar

***Device made by Microdot has been tested in half-dozen major programs; electronic spot welding is feature***

PASADENA, CALIF.—Measurement of strain on *Dyna-Soar* during flight will be made by special strain gages electronically welded to the craft's surface in numerous locations. The gages have been proved out on the *X-15* program and are slated for use in several other systems.

Microdot, Inc., producers of the device, utilize several unique construction and welding techniques to achieve the characteristics which make the gage desirable in extreme-environment applications. Typical of programs now using the gage are *Titan, Minuteman, Polaris, Sergeant, Pioneer, Discoverer* and various research programs on high-temperature creep, supersonic sleds, nuclear reactors and wind tunnels.

The gage consists of a length of Evanohm wire encased in a stainless steel tube. The wire is tapered by an exclusive process from .007 in. to .001 in., its small size chosen for high resistance advantages. Insulated by magnesium oxide, the wire touches no part of the steel tube. The insulating medium completely fills the tube, and possesses excellent resistance to ground at high temperatures.



*CAPABLE of operating in various liquids, the gage is used in corrosive fluid tanks to detect action of fluid on tank.*

The series of gages in the Microdot line can measure strain to 5000 micro-inches and above. Temperatures in which the gage will operate stretch from –320°F (liquid nitrogen) to 750°F static or 1500°F dynamic. Temperature compensation eliminates necessity for a dummy gage at temperatures below 750°F. During operation, the gage can be accidentally smashed flat without causing a short circuit.

Electronic spot welding to the surface to be monitored is a capability of the gage which has attracted most interest among extreme-environment-test conductors. Welding is done by a "Rollectrode" operating on 24 vdc. A powered wheel designed for optimum spot weld spacing can be angularly rotated and locked in any position for attaching gages in tight spots.

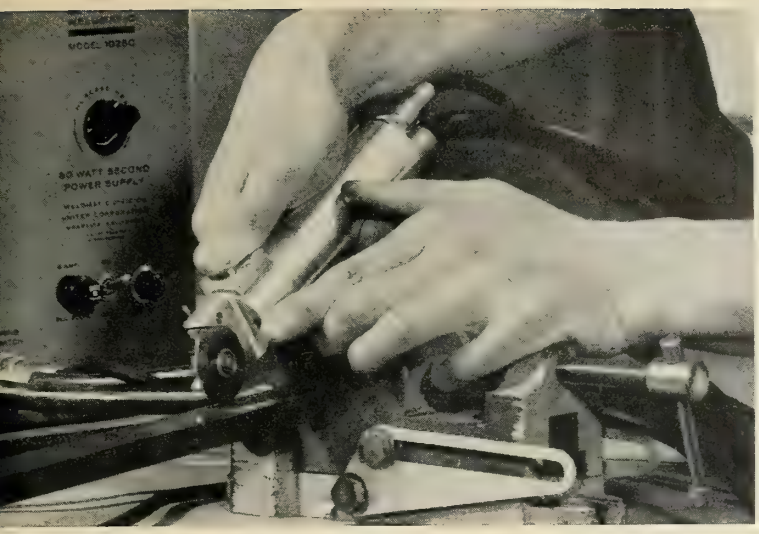
The replaceable wheel is operated by a 12,000-rpm motor, geared down to one rpm at the electrode. A powered wheel is used because a free wheel would tend to stick. The Rollectrode is compatible with any capacitor-discharge welder.

A sector wheel equivalent to one gage length is also available for the Rollectrode to provide ease of welding in confined areas. Two button switches on the unit start and reverse the wheel.

Gages are weldable to steel, aluminum and other non-ferrous and ferrous metals, and are unaffected by radiation fields. Gage size is variable, with length of either 9/16 in. or 1 5/32 in. and widths of 1/4 in. or 1/8 in. available. Height is .020 in. ⌘

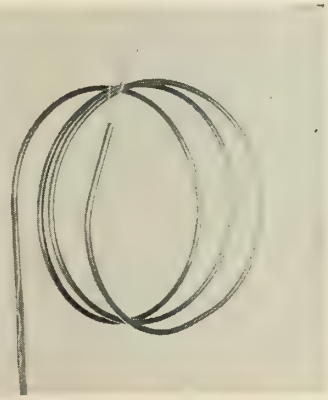


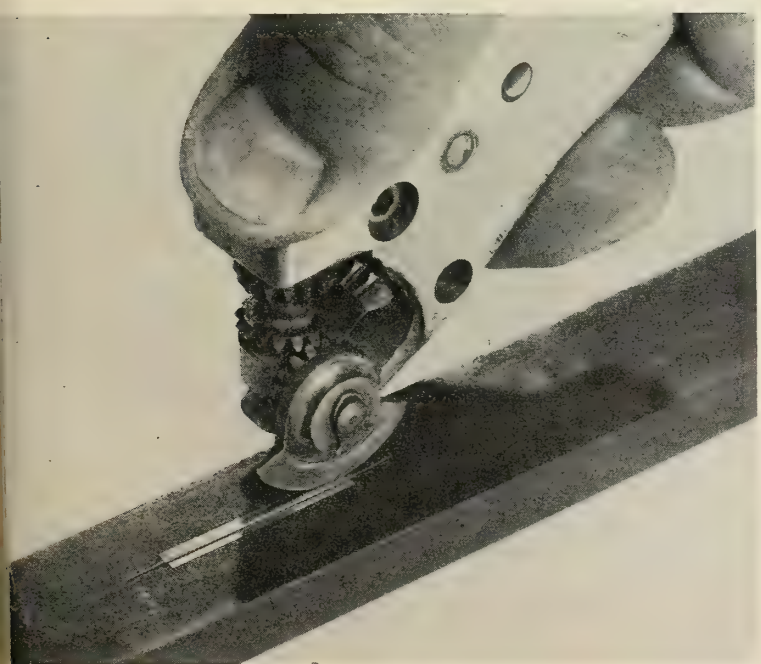
*ELECTRONICALLY WELDABLE strain gages for use on the Dyna-Soar are selected from a variety of types, depending upon the requirements of the measurement. Both 60- and 120-ohm resistance types are illustrated here.*




**ABOVE:** *The Rollectrode in operation with its powered wheel. The wheel is one gage length in circumference and spaces spot welds at optimum distances while operating at one rpm. The motor, geared down by planetary gears, operates at 12,000 rpm on a 24 vdc power supply.*

**BELOW:** *The Rollectrode sector wheel for use in confined space permits the operator to achieve maximum use of the tool. The wheel can be angled and locked in any position during welding.* **RIGHT:** *Some gages can be equipped with an integral lead of stainless steel fused to the gages outer tube. The unit is then helium-tested for leaks and can be immersed in corrosive media. Resistances of 60 or 120 ohms can be provided in the design.*





# PMR Facilities

## Acoustic Chamber and Centrifuge Are Added

AN ACOUSTIC TEST chamber and a 32-ft.-diameter centrifuge have been added to the rapidly mounting list of test facilities available to Pacific Missile Range.

The acoustic chamber can produce sound pressures up to 156 db. It may be used to generate specific frequencies or reproduce tape-recorded sounds of actual missile firings or other events which can be used as inputs for studies of specific problem areas. Included in the system are 32 large electromagnetic speakers and three large air-driven speakers, each as powerful as 750 average "hi-fi" speakers. The three large units may use as much as 200 cubic feet of air per minute during high-level operations.

Personnel of the acoustics laboratory plan to record and measure sounds of missile operations at Point Mugu Naval Missile Center and other PMR installations, and duplicate them in the chamber for test of fully assembled small missiles or subassemblies and components of larger missiles.

Some studies of the human body's stress limits are planned for the chamber. The acoustic facility, located in PMR's new Environmental Simulation Laboratory, was designed by engineers and the Naval Missile Center and built by the Center's Technical Support Directorate.

The 32-ft. centrifuge is said to be the only one of its kind. Also designed at NMC by the Environmental Applications Branch, the device is simply a large turntable driven by multiple hydraulic motors at the table's rim. The large surface area permits test of equipment at simulated high altitudes.

Rim speed of the centrifuge is over 150 mph with a capacity of 50,000 gravity lbs., equal to a 1000-lb. load at 50 g.

A counterweight is required for test packages on the turntable. This may be either another test package, equipment for special environmental conditioning of the test package, or a dead weight. The design includes considerations of this approach—in effect, doubling the device's capacity.

There are also provisions for loading the big centrifuge from an auxiliary disc to simulate sudden acceleration of a stationary object.

NMC's Technical Support Directorate also built the centrifuge, located in the Environmental Simulation Laboratory. Full operation is expected by mid-year, but the acoustic test chamber is already in operation. ⌘

# Marshall Center Seeks Wings for Saturn Landing

WERNHER VON BRAUN'S engineers have decided to try to develop wings for *Saturn* so it can be recovered on dry land.

Von Braun's Marshall Space Flight Center has awarded two contracts totaling $315,827.91 for study of a paraglider recovery scheme put forth by a scientist at another research center of the National Aeronautics and Space Administration.

The Marshall center awarded six-month contracts of $170,000 to North American Aviation's Missile Division and $145,827.91 to Ryan Aeronautical. At the same time, Marshall confirmed that it has cut back its contract with Cook Electric for development of a parachute-borne water recovery method, because of the time and expense involved in reconditioning the 100,000-lb. booster after immersion in salt water.

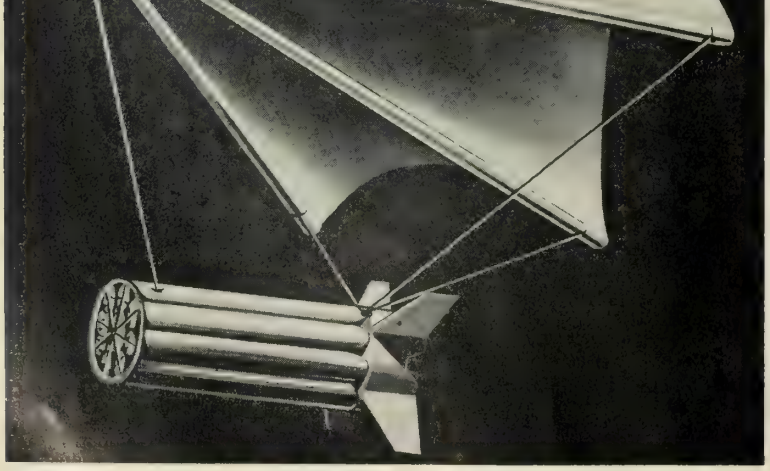
The paraglider recovery plan for *Saturn* was developed by Francis M. Rogallo of NASA's Langley Research Center. It calls for lightweight flexible wings that would be folded longitudinally before release between the outer booster tanks. They would be triangular shaped and connected in tandem. As the booster returns to the atmosphere from space, air flow would open the wings, just as it opens a parachute. Hence the name paraglider for the projected recovery system.

The North American and Ryan studies will also take up problems of glide control, deployment and landing systems, to work out ways of getting the booster back to dry land after it is released.

No effort will be made to recover *Saturn* boosters in early flights. The studies will also make a preliminary investigation of feasibility of recovering the *S-II* stage, the 800,000-lb.-thrust liquid hydrogen vehicle that will be used on *Saturn* C-2.

• **Fins for Saturn?**—Still another question raised in the studies will be the problem of adding fins to the *Saturn* booster in the event it is used to launch winged payloads. The Air Force found it necessary to redesign *Titan* by adding fins to increase aerodynamic stability on the upward flight when carrying *Dyna-Soar*. If the NASA *Apollo* should have wings for re-entry, the question then arises whether to add fins to the *Saturn* booster.

The previous booster recovery method planned for *Saturn* called for alignment of the booster with hydrogen peroxide jets before re-entry, followed by the use of an inflatable drag cone for stabilization. Then a parachute system would have slowed it and retro-rockets would have slowed it further just before hitting the water. ⌗



*RECOVERY GLIDER for Saturn space booster will be studied as a possible means of bringing the big booster down on dry land under two NASA contracts, one with North American Aviation and the other with Ryan Aeronautical. The booster is shown with fins for possible later use with winged payloads.*

# Solid Savings

## Switchover in Booster Fuel Urged by Geckler

SALT LAKE CITY—Shifting from liquids to solids for space vehicles in the *Saturn* and *Nova* class would save at least 30% in cost, an Aerojet-General executive declares.

Richard D. Geckler, vice president and general manager of Aerojet's Solid Rocket Plant at Sacramento, told an American Rocket Society meeting last week that a segmented solid rocket system could be ready by 1964. Every payload from *Atlas* to *Nova* size could be carried by the segmented solid rocket, either single chamber or clustered, he asserted.

No further progress in the state of technology is needed to bring the large solid-propellant booster to reality, Geckler added. "We propose to construct the segmented system along design lines already well proven in large solid rocket programs. We will not seek the ultimate in performance, but rather the ultimate in reliability."

While the Aerojet executive confined his remarks to the segmented booster, some others in industry, particularly in Thiokol Chemical Corp., are proposing the large one-piece solid rocket, cast at the launch site or transported by barge, as the solution.

Geckler estimated that it will cost $15 million to launch a four-stage *Saturn C-2* of the currently planned all-liquid design. If a solid booster were substituted, he said, the cost would fall to $8.5 million. He said the 45% saving would be achieved by using a 140-in. single-chamber segmented solid first stage.

Similarly, the cost of launching the proposed *Nova* vehicle would drop from $60 million to about $38 million a copy, Geckler continued. He maintained that the segmented solid rocket in the *Nova* class could be ready by 1964, four years ahead of a liquid vehicle.

Aerojet-General, which is doing a feasibility study of large solid propellant units for the Air Force, has conducted preliminary design analyses of segmented solid rockets as Jato units for *Atlas* and *Titan* boosters. (The Russians reportedly have done something similar to boost the load-carrying capacity of their big space booster.)

Two segmented boosters as Jatos would add 200,000 lbs. of takeoff weight but would double the thrust of an *Atlas* or *Titan* and would add 4000 lbs. to their payload in a 300-mile orbit, Geckler declared. The cost per lb. of added payload would be 30% less than the cost of the original payload. ⌗

# Alinement for Minuteman-on-Rails

***Autonetics' developed unique system for optical alining which is built into the missile itself***

**by Richard van Osten**

OPTICAL ALINEMENT of the *Minuteman* guidance package is one of the more difficult design problems encountered in basing the solid-fueled ICBM aboard trains.

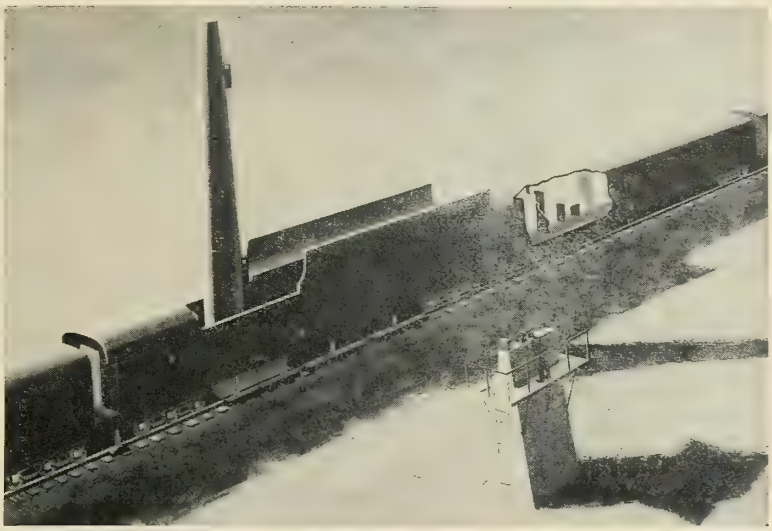
First details of the mobile system were disclosed at a recent Development Engineering Inspection (DEI) in the Seattle plant of Boeing Airplane Co., prime for the program. It differs radically from the hardened, silo-based system—where a small gallery is provided at one side of the silo's northeasterly upper section for autocollimating and other alinement equipment.

To duplicate this system on a train, it would be necessary to carry around a large tower. This would hardly be practical. Hence the Autonetics Division of North American Aviation developed a unique alinement system which is built into the missile with readout in the guidance and command car.

Autonetics designed and built the entire Trainborne Operational Equipment (TOE), of which the alinement system is a part, used with the mobile concept. (M/R, Jan. 16, p. 35). The division also is the associate contractor for airborne portions of the guidance and control (G&C) system. Most of the TOE system was developed by Autonetics' Computers and Data Systems Div., headed by Dr. Norman F. Parker.

Designated the Missile Alinement Set (MAS), the alinement equipment is permanently installed in the missile car.

To speed up missile alinement, an accurate base azimuth is supplied by a gyrocompass, rather than a bench mark or stellar reference as is possible for a fixed emplacement. It is necessary that the rail heading at each launch station be pre-surveyed with sufficient accuracy to permit an initial "rough-North" gyrocompass orientation. Azimuth is transferred from the gyrocompass to the missile guidance package by means of electro-optical equipment on the gyrocompass, and equipment on an elevated leveled platform located near a window in the guidance package.



*ARTIST'S CONCEPTION of the Missile Alinement Set (MAS) for the trainborne Minuteman being calibrated at a Missile Unit Support Base (MUSB).*

• **Subsystems in blisters**—The gyrocompass, a twist autocollimator, autocollimator platform, and associated electronics and cabling make up subsystems of the MAS. They are located in blisters on the missile's strongback. The lower blister also provides space for the gyrocompass operator. The optical path for upper and lower portions of the optical system is also enclosed by the strongback, furnishing the missile and the MAS with the same ambient environment.

The three subsystems are controlled by an operator at the gyrocompass control panel. The panel contains four go/no-go lamps to indicate system status. The panel also has a power-on lamp, gyro-cage switch, a switch to slew the gyro to rough-North and a target-angle-set switch. The latter enables the operator to indicate to the command car whether or not target angle has been set into the missile guidance system.

The gyrocompass is a single-axis, pendulous, north-seeking gyro. Within its casing are servos, servo electronics, a gyro motor power supply, synchro transmitter and optical scales. External features include a control panel, scale-reading microscopes, and a load-supporting rotary table which can be oriented to target azimuth.

• **Gyro in action**—To operate the gyrocompass, the gyro is brought up to speed and its spin axis oriented within 5 deg of arc of geographic North. The gyro is then caged. Spin-axis displacement from North causes the earth rotation coupled to the gyro to bring the spin axis toward North. Because this motion is negligibly damped, the spin axis passes through North to return and oscillate about the North direction with a period of eight minutes. Gyrocompass-indicated North is taken as the azimuth midway between easterly and westerly peak positions achieved by the gyro spin axis.

Maximum decoupling of the gyro from accelerations transmitted through its mounting is provided by locating the unit within a float suspended by a thin fiber from the top of an enclosing tank which can be motor-driven about a vertical axis in line with the fiber.

The tank's silicone fluid provides sufficient bouyancy to remove a major portion of gyro weight from the suspension fiber. Lateral bouyancy pro-

vided by the fluid minimizes the effects of horizontal accelerations on the gyro as a result of vibrational environment. Undesired oscillations and other disturbances of the gyro are also damped by the fluid. To minimize environmental disturbances further, the tank's bearing housing is servo-stabilized with the aid of leveling gyros.

Between the gyro float and the tank a pickoff signal is developed which displays gyro azimuth oscillations relative to the tank. To null this signal, the suspension-fiber-support tank is servo-driven about the vertical axis—the followup servo tracks the direction of gyro spin axis. Damping of the gyro desired-azimuth oscillation is minimized through followup of the suspension fiber to eliminate torsional reaction on the gyro and through tank followup of the float.

The lower of two optical scales is mounted to the top of the fluid tank. In effect, this enables an operator, viewing the scale through a microscope, to read out peak displacements of the gyro spin-axis to determine North direction. A table, free to rotate about the vertical axis, is on top of the gyrocompass and supports the lower unit, or "transmitter," of the twist autocollimator. The rotary table and its load are maintained in a level attitude because the table is supported upon the level-stabilized bearing housing of the gyro followup assembly.

An upper microscope eyepiece and an upper optical scale rotating with the optical table permit the operator to set into the table a North reference derived from the lower optical scale. In addition to this North reference, a target angle from North is inserted, thus orienting the twist autocollimator transmitter to the target heading.

A porro prism, located on the rotary table, references table rotation and permits a theodolite operator to compare the gyrocompass-indicated North direction with a surveyed bench mark North reference as during calibration and checkout.

During storage or transport, or when setting in rough-North, the gyro float is kept in a caged condition, so that motion relative to the fluid tank is prevented and the suspension fiber is relaxed. During orientation to rough-North, the fluid tank followup servomotor is run until the gyro spin-axis orientation is appropriate, as read out from the lower scale. The gyro is uncaged only to allow azimuth oscillation of the spin axis or when readings are intended to be taken.

The gyrocompass also has a built-in, crystal-controlled, 400 cps power supply for precision gyro rotor speed control. To provide coarse pitch leveling information for the autocollimator platform, a synchro transmitter is incorporated on the gyrocompass leveling servo.

• **Autocollimator** — Three separate assemblies make up the twist autocollimator subsystem: a lower unit mounted on the gyrocompass rotary table; an upper unit mounted on the autocollimator platform; and a combined power supply and junction box assembly located near the gyrocompass. The latter unit is common to signal and power circuits for all MAS subsystems.

The lower unit assembly consists of the optical synchro transmitter which directs a beam of light to the upper unit assembly. Rotational or "twist" information, consisting of target azimuth, is conveyed upward on this beam. A porro prism on the lower unit facilitates azimuth alinement to the gyrocompass optical table which also bears a porro prism.

The upper unit assembly, positioned approximately 45 ft. above the transmitter, contains the optical synchro receiver which extracts twist information from the vertically projected beam. Also packaged in the upper unit is a dual-axis autocollimator which projects a horizontal light beam through a window in the missile to a mirror in the missile guidance system. The azimuth direction of this beam represents the target azimuth set into the gyrocompass rotary table. The upper unit's optical package also contains electronics for twist autocollimator and a porro prism for azimuth monitoring of system performance.

• **Correction by beam**—The determination of any misalinement between the optical synchro transmitter and receiver is accomplished with a complexly modulated light beam.

Light from an incandescent source is circularly polarized, collimated, and then operated upon by a solid-state electro-optic light modulator. Under application of a high-voltage alternating field, the modulator changes the circulary polarized light into two superimposed, intensity-modulated, plane-polarized beams with polarization planes at right angles.

The composite beam then passes through a quartz correction crystal and is projected upwardly in a diverging path toward the optical synchro receiver. This beam represents the twist orientation of the transmitter, and thus contains target heading information. The correction crystal serves to compensate for the effect of some cross-coupling factors on azimuth accuracy as the optical synchro receiver samples random portions of the upwardly projected beam due to some sway of the missile strongback.

At the optical synchro receiver, the modulated light beam from the transmitter is sent through a quartz plate into a modified Wollaston prism. The prism is so mounted that, like the plate, its sensitive axes are at 45 deg (arc) to the polarization axes, defined by the transmitter. This prism also physically separates light having polarizations 90 deg (arc) apart and directs light of one polarization to one solid-state photodetector and light of another polarization to a second photodetector.

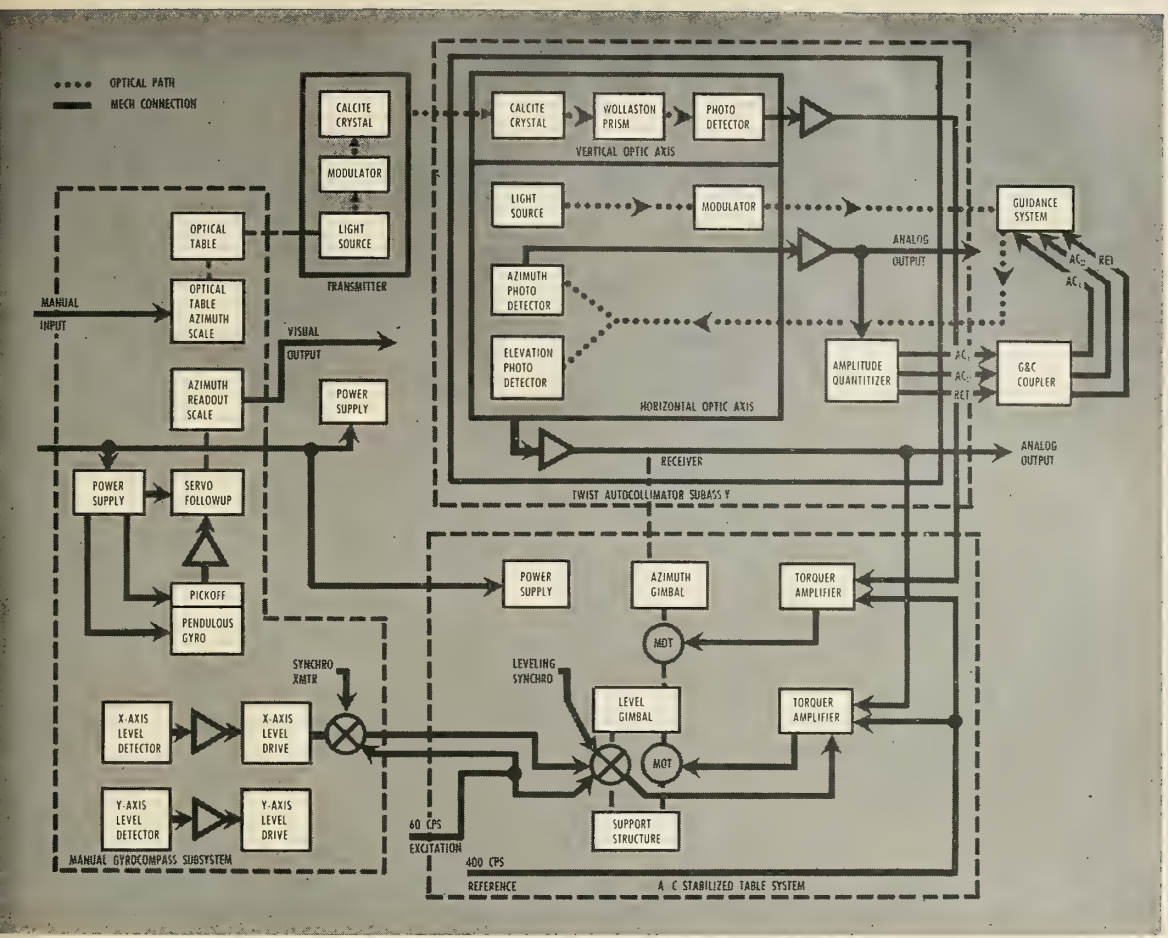
When the receiver is rotationally alined to the transmitter, orthogonal components of each polarization component of the intercepted beam are combined at each photodetector to provide constant light intensity and a DC signal not sensed by the phase detector. However, when twist misalinement exists between the receiver and transmitter, the two photocells observe modulated light beams of opposing phase.

• **Twist signal input**—After separate amplification, detector AC signals are joined at a phase demodulator where the output error signal is proportional in magnitude to the amount of twist between upper and lower optical synchro units. This twist error signal serves as the input signal to the autocollimator platform azimuth axis servo.

In the dual-axis autocollimator, a circular aperture image is projected, and its reflected position is sensed by azimuth and elevation sensing solid-state photodetectors. Light from an incandescent source is modulated in much the same manner as in the optical synchro transmitter, and is projected to the guidance system stable element mirror.

When the mirror is alined, return light falls upon an analyzer reticle so that a photodetector behind the analyzer receives constant light and provides a DC signal which cannot pass the phase demodulator transformer.

The analyzer is composed of two semi-circular polaroid filters, adjoined base-to-base to form a circular element with a straight-line division between polarization vectors 90 deg. (arc) apart. When monitored mirror misalinement exists, the image displacement at the analyzer causes the detector to see more light of one polarization and phase than of the other polarization and phase. By this means, an AC signal is developed which results in a phase demodulator output having a polarity representing the direction of mirror misalinement, and having a magnitude




**Functional Schematic for Missile Alinement Set**

representing the amount of misalinement.

An analog output signal from the dual-axis autocollimator elevation is sent to the autocollimator platform leveling servo. This provides the autocollimator with the pitch-level attitude of the missile guidance system stabilized platform which is within ±10 sec. arc.

• **Signal conversion**—The azimuth analog signal is converted within the autocollimator electronics to a three-state output on two lines. A given line will either have a signal (the 1-state), or no signal (the 0-state). A (0, 0) output on the line pair represents azimuth alinement of the missile mirror to the autocollimator within ±5 sec. arc. A (1, 0) or (0, 1) state indicates clockwise or counterclockwise error in excess of 5 sec. arc. The three-state output of the twist autocollimator is sent to the Guidance and Control Coupler which causes the G&C computer to torque the missile platform to target azimuth within 60 sec. arc (standard deviation, ±5 sec. arc).

The autocollimator platform consists of a two-axis stabilized mount to position the upper unit of the twist autocollimator in azimuth and level. The platform is enclosed in a housing supported on the missile strongback adjacent to the missile alinement window.

On the inward side of the mounting bracket (for the platform housing) to the missile strongback in a vertical outer gimbal, pivoted within and from the housing about a pitch axis with a ±3 deg. arc of freedom, and an inner gimbal, pivoted about an azimuth axis within the outer gimbal, with ±5 deg. arc of freedom. An in-line direct drive torquer motor is employed on each gimbal axis. In addition, a synchro receiver is provided on the pitch axis. The latter axis lies in a direction at right angles to a line-of-sight into the missile alinement window. Mounted within the inner gimbal is the twist autocollimator upper unit. Electrical connections to the autocollimator and gimbal torquers are achieved by flexure wires across the gimbal axis.

Three optical windows are provided in the platform housing: one for the horizontally viewing dual-axis autocollimator section of the upper unit; one for the optical synchro section; and a third to permit viewing of the upper unit porro prism at an upward angle of approximately 45 deg. arc.

Inputs to both gimbal torquers are supplied from the upper unit electronics package which is mounted on the missile strongback and contains the platform servo electronics. The pitch torquer signal is derived from the dual-axis autocollimator elevation axis output, but this output is available only after the platform is rough-leveled by the synchro loop to the gyrocompass.

The azimuth torquer signal is derived from the optical synchro transmitter output. Leveling of the platform is necessary to eliminate cross-coupling effects which would otherwise degrade azimuth alinement. Leveling of the upper unit porro prism is necessary to prevent azimuth readout error, when monitoring it at a steep angle from the ground during checkout. ⌗

*Elaborate plans . . .*

# Navy, AF Teams Set For Recovery Of Astronaut

**Fleet force is responsible for probable landing areas; Air Rescue Service has job of covering rest of world**

**by Jay Holmes**

HISTORY'S MOST FAR-FLUNG operation to save the life of one man will swing into operation with the first of the Project *Mercury* manned orbital flights.

The Air Force's Air Rescue Service is preparing to deploy pararescue men with special underwater training in five of the seven seas, poised to pluck the capsule and its human passenger from any point in the ocean along the path of the three *Mercury* orbits.

Nine pre-planned impact areas in the North Atlantic have been selected by the National Aeronautics and Space Administration and the Navy's Destroyer Flotilla 4, responsible for covering high-probability landing areas. The Air Rescue Service will be responsible for covering the rest of the world.

The operation planned for manned orbital *Mercury* flights is much more extensive than that in operation last week for the suborbital *Mercury Redstone* ballistic launch. Only two areas, that around the Cape itself and one around the intended landing area, 290 miles downrange, needed to be covered. The entire *Redstone* recovery operation was handled by eight ships and numerous small craft, aircraft and land vehicles of Destroyer Flotilla 4, commanded by Rear Adm. F. V. H. Hilles.

For the *Atlas*-boosted manned orbital shots, expected to begin about a year from now, ARS has set up provisions to reach any point on earth within 18 hours. Navy and Strategic Air Command aircraft will be aloft above all parts of the three orbits during the capsule's programed 4½-hour flight. They will have 1½ hours to move from one area to another as the orbit precesses.

• **Sea spells trouble**—If the capsule comes down on level dry land, rescuers will have little difficulty. Each orbit, however, brings the spacecraft across broad areas of Africa and Australia—where it is likely to land in remote jungle or desert regions. Pararescue forces will be prepared for such eventualities.

But the most complex problems will develop if it plunges into the almost endless stretches of the North Atlantic, South Atlantic, North Pacific, South Pacific and Indian Oceans outside the planned impact areas.

For the sea rescue job, Air Rescue Service will deploy 56 volunteers specially trained in techniques for using Self-Contained Underwater Breathing Apparatus (SCUBA). Half of the 56 will be assigned to Destroyer Flotilla 4 for service in the nine pre-planned land-



*IN LESS than five minutes, pararescuemen in drill have jumped from plane, made "nylon letdown," affixed flotation device to capsule, and await pick-up. In actual operation, they would open capsule and aid astronaut.*

ing areas. The remainder will cover the seas around the world.

The first *Mercury* rescue volunteers began training last summer at the Navy frogman school at Key West. The first two men in the program, M/Sgts. William R. Hyatt Jr. and Charles Tolbert, are now at Air Rescue Service headquarters at Orlando AFB, Fla., developing techniques for the men who will follow.

Some of the airmen will have the benefit of some particularly pertinent experience helping recover *Discoverer* capsules from the Pacific Ocean. As many as eight pararescue men have been assigned to some of the *Discoverer* operations.

• **Split-second operation**—In general, the rescue men will be deployed on a "buddy" basis, two in each plane. Thus, 28 pararescue aircraft will take part in a *Mercury* orbital operation, 14 in the planned recovery areas and 14 around the world. However, altogether as many as 60 Air Force, Navy and Coast Guard aircraft may take part, the others serving as spotters and in other auxiliary duties.

The SCUBA-trained pararescue man will carry 160 lbs. of equipment, including 20 lbs. of lead weights to allow him to swim under water—for maximum speed in reaching the floating capsule. Here is the planned recovery procedure:

–Drop spotter's chute toward capsule. Count seconds until aircraft is over the capsule, so as to know how long it will take on the next pass.

–Jump.

–Get rid of reserve chute while airborne.

–Deploy rescue raft, which inflates in the air.

–Attach first aid kit to long lanyard.

–Pull pins releasing chute just before reaching water surface.

–Impact within 10 ft. of raft.

–Orient self on capsule.

–Attach lanyard to raft.

–Swim underwater to capsule.

–Plane drops flotation device, a specially modified 20-man raft.

–Inflate flotation device, slip it under capsule and float it.

Meanwhile, the second pararescue man has joined his partner. The rescuers can unbolt the side cover of the capsule after it is on the floating raft, if the astronaut has not already opened either the top or side exit from inside.

The rest of the operation is routine. ⁂



**ABOVE:** *Air Rescue Service SCUBA team prepares for jump. MSgt Nicolas Klimis double checks rigging worn by TSgt Joe L. Williams. Equipment surrounding the men weighs as much or more than either of them.* **BELOW:** *Klimis holds flotation device firmly in place while Williams starts to hand crank the "purse string" retainer cables tight. When this task is completed, the flotation collar will be inflated and the rescue team will, if necessary, climb aboard to help the astronaut.*



# New Formula for Pricing Space Work

## *AAS meeting told of Chance Vought cost analysis method; 8-year moon round trip plan tagged at $3.1 billion*

AN EIGHT-YEAR PROGRAM, culminating in manned lunar landing and return, would carry a price tag of about $3.1 billion.

The figure is the result of applying a cost analysis method developed by Chance Vought Corp. to a sample space program; it represents all expenses except booster development costs and existing facilities.

Details of the analyzing process and the space mission were presented to the American Astronautical Society by T. E. Dolan, W. G. Long and R. H. Lundberg at the seventh annual meeting held in Dallas recently.

By mission phase, the program costs for manned lunar landing and return (MALLAR) through oribtal qualification of the command module are $771 million, while earth oribtal qualification and demonstration of the manned command/mission/assembly is $603 million.

Breaking the total down even further, the actual hardware costs of the specific MALLAR mission, the program objective, is about $21.2 million. Ground tests would cost $145 million while total tests, including flight, would reach $875 million.

Crew training would gobble up $42.7 million but Vought studies in other areas indicate that this could be reduced through sophisticated flight simulation facilities. Flight operations are tagged at $273.6 million, support costs at $91 million and spares costs at $86.3 million.

A generalization of the theoretical lunar mission permits the following conclusions:

–Manned space missions in the next 15 years will include up to 75% of the program costs in non-recurring and/or developmental areas. Thus in the specific example, the second mission would cost only $200 million.

–Space system cost analysis information equals technical feasibility in importance to the potential customer.

–The weakest area of true program cost forecast lies in availability of basic cost data and conversion of apparent costs to actual costs.

Other papers presented at the meeting included:

–The effect of the Martian upper atmosphere and ionosphere on communications was covered by G. Yanow of Douglas Aircraft Co. Yanow reported on preliminary results for density, temperature, mean molecular mass, electron density and other atmospheric characteristics derived from hypothetical Martian models composed of 95% $N_2$ and 5% CO2. If current values of the Martian environmental conditions and chemical composition are taken, it is plausible to suggest the existence of a fairly dense, multilayered, high altitude ionosphere about Mars.

This further suggests that terrestial communication techniques could be employed but using different frequencies and skip distances.

–The adverse effects of space vehicle rotation on man and inanimate objects was presented by G. T. Beauchamp of Lockheed's Missiles and Space Division. A study of the Coriolis forces acting upon moving bodies within rotating vehicles reveal a definite pattern which dictates certain requirements in vehicle design.

Beauchamp concludes that the optimum vehicle radius at floor level should be from 45 to 50 feet. Smaller radii will result in intolerable Coriolis components and gravity gradients.

For satisfactory human operation at low simulated gravity levels, the vehicle rotational radius would require extensions to several hundred feet.

–Impact on vehicle design by the requirement of producing artificial gravity were discussed by A. M. Mayo, Life Sciences Program, NASA. The need for artificial gravity is generally recognized, based on the absolute demand for optimum efficiency from an astronaut.

• **Spin effect**—Mayo suggests at 1 rpm rotation with a 1 G equivalent acceleration to induce this artificial gravity. This would require a radius of rotation slightly under 3,000 ft. involving a weight penalty on the order of 10% of the initial orbiting weight of a vehicle system.

–The mass shielding requirements for flight during extreme solar flare proton events were covered by T. Foelsche of NASA's Langley Research Center.

During maximum activity, a cylindrical shelter of $H_2O$ equivalent material having an inner diameter of 1 meter would be needed. This means a weight factor of 4000 to 5000 lbs.

The examples for calculation of doses behind different amounts of shielding were chosen from the high energy event on Feb. 23, 1956, the low energy extreme flux events from May 10 to July, 1959 and the high flux event of August 22, 1958.

–The "atmosphere" of the moon was described by S. Fred Singer of the University of Maryland. The atmosphere is the result of the moon's being positively charged by solar ultraviolet photon action. This space charge field is strong enough to affect radio communication at low frequencies.

Besides this, says Singer, the field kicks out small, positively charged dust particles from the lunar surface. These reduce and partly cancel the negative space charge of the electron cloud and allow the cloud to expand to a greater distance of the order of a meter. The electron field is also reduced and the dust particles fall back to the surface but are replaced by others. Singer concludes that the moon has a dust atmosphere of positively charged dust particles and negative electrons. ⁂

## Lockheed Building Reactor for NASA

Lockheed's Georgia Division will build a low-power nuclear reactor for the National Aeronautics and Space Administration at its Plum Brook facility near Sandusky, Ohio.

NASA awarded Lockheed a $404,-002 contract to build the reactor by 1962. It will be used to check feasibility of proposed experiments on the 60-megawatt research reactor, which NASA says is to go critical in March.

The Atomic Energy Commission has extended the completion date of the high-power reactor from Jan. 1, 1961, to Jan. 1, 1962. The AEC said NASA reported the delay was necessary because of imperfections in manufacture of the reactor tank, additional piping work and other problems. ⁂

### *Where to Get 'Birdsmanship'*

M/R's review of Strictly Birdsmanship (Jan. 23, p. 44) neglected to mention the address of the Benson-Lehner Corp., the only place where copies can be ordered. In answer to numerous inquiries, the address is:

1860 Franklin Street,
Santa Monica, Calif.

## Kennedy—Defense

(Continued from Page 16)

uncertain risk and great commitment," he said. "Each day we draw nearer the hour of maximum danger as weapons spread and hostile forces grow stronger."

This was as close as he came to saying that the Missile Gap is generally expected to be at its greatest in 1962 and 1963.

Kennedy's immediate steps to meet this danger were to call for a speed up in construction of *Polaris* submarines, procurement of more military cargo and transport aircraft and acceleration of "our entire missile program."

He said the last item would be confined mostly to "improving organization and decision making" while he awaited McNamara's reports. The first two items involved hardware.

The call for more airlift—possibly more than 200 planes—was widely interpreted in the Army and elsewhere to mean that much greater emphasis would be put in the future on modernizing the Army's semi-starved combat divisions.

This could mean sizeable increases in the procurement of such tactical missiles as nuclear-tipped *Davy Crocketts, Sergeants* and *Pershings*. It also might mean approval of the Army proposal to extend *Pershing's* range to 1000 miles.

• **Saving nine months**—The increase for *Polaris* doubled from 5 to 10 the number of *Polaris* sub keels that have been approved by the Administration for FY '61. They will be paid for partly with funds borrowed from the *Polaris* sub account. No new money is required now.

The final Eisenhower budget submitted to Congress last month repeated the order for FY '62: Five more *Polaris* subs and lead time items for another five.

Kennedy now has proposed to take the five subs out of the FY '62 budget and put them in the budget for FY '61. In effect, he is doubling the FY '61 order and leaving the FY '62 order to be filled in later.

The Kennedy order means that nine months can be saved in building the five additional subs. It also means that the Navy will begin launching a *Polaris* submarine a month in October 1963. This can go on as long as the nation continues to build 12 a year.

In all, 24 *Polaris* submarines have now been authorized or are under construction. The Navy also is preparing to arm the nuclear-powered cruiser Long Beach with eight *Polaris* missiles.

The Long Beach is scheduled to be commissioned early this fall. Then, after a three-month shakedown cruise, it will undergo 20 months of yardwork including the installation of tactical radars, fire control equipment and *Polaris* launching tubes.

So far, the Long Beach is the only cruiser that the Navy has been authorized to arm with *Polaris*. However, proposals to arm others are certain to be pressed.

Navy officers were delighted that *Polaris* was the only one of the Big Four strategic missile systems that Kennedy mentioned by name in his State of the Union Address. Many felt that Navy proposals to build a fleet of 45 *Polaris* submarine seldom looked more assured.

However, all three services took at least some comfort in Kennedy's statement that his Administration would give equal attention to the olive branch and the arrows grasped in the talons of the American eagle on the Presidential Coat of Arms.

It also was noted that at this point both the Democrats and the Republicans applauded. ⌗

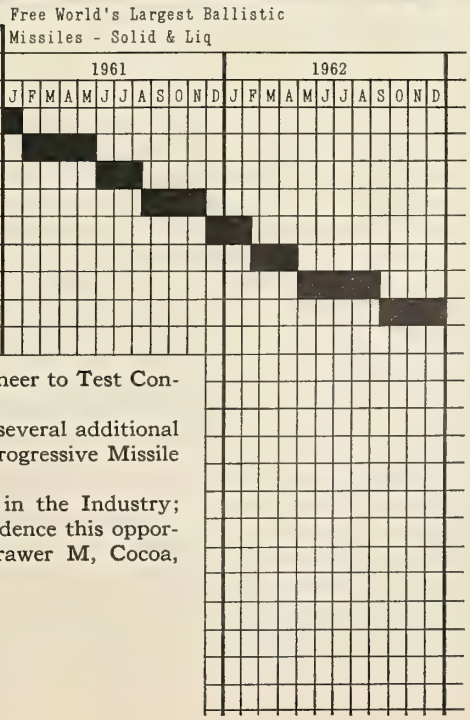

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|---|---|---|
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| 2 | " " " " " Prop. | 15% |
| 3 | " " " " " El. | 10% |
| 4 | " " " " " F/C | 15% |
| 5 | " " " " " M/S | 10% |
| 6 | " " " " " Inst. | 10% |
| 7 | Asst. Test Conductor | 20% |
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| 9 | | |




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MARTIN

# France to be Major Missile Power

***De Gaulle plans on spending at least $2.4 billion in next four years on new special weapons***

**by Bernard Poirier**

UNDER PRESIDENT DE GAULLE'S hard-won new "Program Law" France may achieve a nuclear air/missile strike capability within four years.

The law commits a minimum of $2.4 billion through 1964 for a wide spectrum of new weapons designed to give France the ability to protect her far-flung territory—roughly four million square miles spread around the globe.

Equally important, de Gaulle's ambitious plans would make France a major military power in the missile age.

An analysis of the program indicates that within a year the French defense industry will be moving at high gear—including several U.S. firms with affiliations in France.

Until the Program Law went into effect France would have spent $1.26 billion a year for weapons procurement and development. The money would have been committed on a year-to-year basis, adding up to $6.3 billion over five years.

What de Gaulle has done is to commit 25% of this $6.3 billion in the first year on special weapons.

• **Spending breakdown**—Funds are allocated under the new law by mission rather than strictly by military service. The breakdown:

–Air Force materials—$546 million

–Other aeronautical materials—$281 million

–Ships construction and FBM R&D—$189 million

–Army materials and modernization—$356 million

–IRBM and nuclear development—$986 million.

The Navy portion contains $165 million for a prototype nuclear ballistic submarine, three missile escort cruisers and two Daphané class submarines. It includes $24 million "for the research of a *Polaris*-type missile for the nuclear submarine." The cruisers will also carry new missiles such as the improved *Masurca* antiaircraft batteries.

Fifty Dassault Etendard IVM fighters will be deployed on carriers, particularly the newer Foch and Clemenceau. The Navy also gets 27 Breguet NATO Atlantic patrol aircraft. This buy is financed from $142 million.

A lesser amount for 220 helicopters—some carrying missiles—is shared with the Army. Included are 150 light Alouette types and 70 Frélon types, both manufactured by Sud Aviation. Most of the missile armament on naval aircraft will be provided by Nord and MATRA.

The French Air Force maintains an airborne missile of strike force in the Mirage IV mach 2.2 fighter/bomber. Fifty of these and 226 Mirage III fighters will be procured from a $546 million materials appropriation.

• **Missile armed**—G.A.M. Dassault, maker of both Mirage models, recently set a world's record with the 'IV'. This 1100-1400 mile range aircraft will carry advanced *MATRA* missiles and stand-off nuclear tipped missiles to be developed from $212 million in the missile pot. It will be able to reach most targets in Eastern Russia and return to French bases.

A company spokesman at Saint-Cloud says, "The aircraft will be able to carry French nuclear bombs delivered with air-to-ground missiles. It will carry counter-measure devices against enemy radar plus air-to-air missiles."

Presumably, the counter-devices are Carcinotron-M electronic hyperfrequency units developed by Dr. Robert R. Warnecke's technical group at C.S.F.'s Centre de Physique Electronique et Corpusculaire located at Corbeville par Orsay.



*FRENCH CARRIER CLEMENCEAU and the Foch (same class) will be provided with new, missile-armed Etendard strike fighters, one of which is shown on center deck.*



*FRENCH ARMY has one battalion of mobile surface-to-surface Sud Aviation*

The Air Force will manage a $77 million allotment for continued research on NATO patrol aircraft. This, plus another $56 million, gives this service the largest share—$680 million dollars.

The Army will get new weapons, Algerian troops will be modernized and the same procedure will follow next among French forces in West Germany.

The Army already has one battalion equipped with *Sud 4200* tactical missiles. Undoubtedly, this capacity will be augmented and development of a new *Parca* antiaircraft missile will be accelerated.

*DEFA*'s Research Laboratory at Vernon has already undertaken design and engineering effort for a mach 3 version. It will be deployed against high altitude supersonic aircraft.

Land and sea based IRBM's will be developed concurrently. S.E.R.E.B. is the organization responsible for the R&D effort. Its overall effort will be supported by industrial leaders like Sud, Nord, Latecoère and MATRA. Sud is prime within S.E.R.E.B. for IRBM development and has been supported by O.N.E.R.A. and SEPR. Tests have already been conducted from the Navy's Mediterranean site on Levant Island.

Considerable benefit will be derived from their experience with anti-tank missiles, ASW missiles and air launched missile systems. Moreover, MATRA has developed the solid two-stage *R 422* which has been tested on *Véronique* complexes at Hammaguir.

In a New Year's Eve report to the people de Gaulle said, "We are continuing the vast scientific, technical, educational and economic development in which we have been engaged and which leads to prosperity, influence and strength, and which throws open careers to more (within our) young generation."

## French PROGRAM LAW for Defense

*(in millions of dollars)*

| | TOTALS | Army | Navy | Air Force | Common R&D Effort | | |
|---|---|---|---|---|---|---|---|
| | | | | | Missiles | Aircraft | Nuclear |
| Air Force Materials | $ 546 | .. | .. | $546 | .. | .. | .. |
| Non-AF Air Materials | $ 281 | .. | $142 | $133 | .. | $ 6 | .. |
| New Ships Construction and FBM Development | $ 225 | .. | $165 | .. | $ 24 | .. | $ 36 |
| Army Materials | $ 356 | $300 | .. | .. | .. | $ 56 | .. |
| Strike Force RDT & E | $ 950 | .. | .. | .. | $188 | .. | $762 |
| TOTALS | $2,358 | $300 | $307 | $679 | $212 | $ 62 | $798 |

The real big push will be in the area of deliverable nuclear packages. At least $762 million is available.

Cost of the first French A-Bomb is estimated at $400 million. Further, the nuclear isotope separation plant at Pierrelatte will cost about $300 million.

Other French studies reveal research costs for a *Thor*-type missile would be seven times cheaper in France, and fabrication, three times cheaper. They claim only $24 million has been expended to date on missile research and with comparable success. This figure appears low.

To support IRBM development, the Law includes $45 million for solid propellants and an equal amount to augment existing test facilities. Total cost up to the production model is projected at $800 million.

No amounts are given for other essential portions of an IRBM weapons system.

On the other side of the ledger, a high ranking French Comptroller estimated that the costs of recapturing enriched uranium for shipboard reactors "would be much higher in France than in the U.S.A.; at least as is foreseeable during the next ten years."

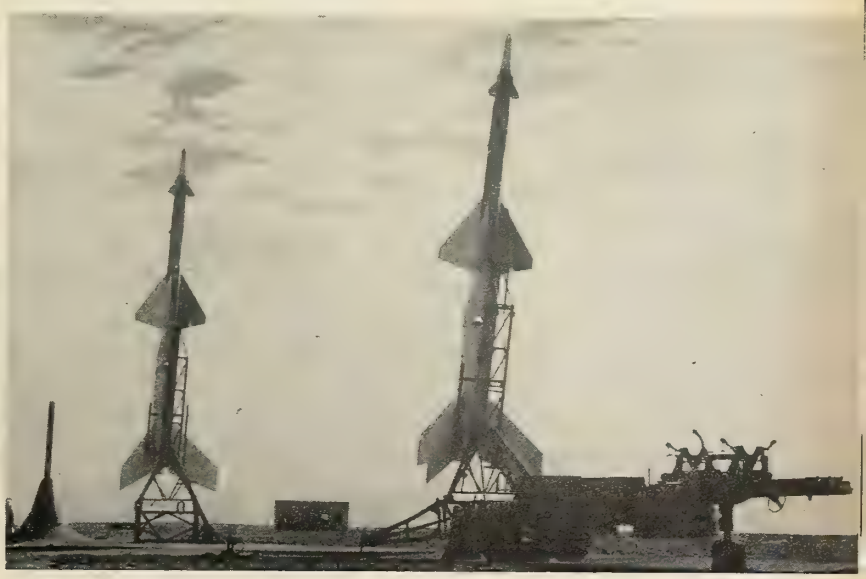
One argument during the debate on the Law revolved around the offer of a nuclear deterrent by the U.S. to NATO in the waning days of the Eisenhower administration. However, analysis points out little which could conflict between this offer and the Program Law. There are apparent advantages to both.

The only disadvantage is intrinsically woven into NATO's geopolitical fabric. NATO is only as strong as the adhesion joining fifteen members and not in the concept of a weakest member. The Cold War has often emphasized the struggle of Western resources versus those of the Soviet camp. Yet NATO, particularly the three largest members, has persisted in redundant investment for research in areas of proven weapons systems.

Many delegates to the recent NATO Parliamentarian Conference recognized NATO's "growing pains" in this area and some legislators hinted at corrective measures for the Alliance. ⁂



*SE 4200 missiles. The radio-guided "Flying bomb" has range up to 55 miles.*



*MATRA R 422 two-stage solid missiles are among the largest developed by France and have been successfully tested. Company will have major role in new program.*

*Early job for Webb . . .*

# How Much More Should NASA Ask?

## Eisenhower budget set new high in space agency funding but was thrice-trimmed below Glennan's request

AMENDMENTS TO former President Eisenhower's budget will be among the first items of business for James E. Webb, new chief of the National Aeronautics and Space Administration. The Kennedy Administration requested NASA's views on the budget even before his appointment.

Eisenhower and his budgeteers cut more than $250 million from the new money sought for fiscal 1962 by former Administrator T. Keith Glennan. The NASA budget went up to the White House and returned at least three times, with deeper cuts each time.

The new NASA Administrator, will have to decide whether to seek the entire amount, something less or, perhaps, more than Glennan wanted. A request for additional money seems certain to be greeted favorably, at least by Rep. Overton Brooks (D-La.), chairman of the House Space Committee. Brooks has said NASA ought to spend at least $1½ billion in the coming year.

The Eisenhower budget calls for $1,119,630,000 in new obligational authority for 1962 and a supplemental appropriation of $49.6 million for 1961. The 1962 request is 22% higher than the final 1961 total voted last year. It includes new money for research and development totaling $819.-million, compared with $621.453 million voted finally last year.

• **Cutbacks**—Several major R&D programs, which NASA has announced would begin in the next fiscal year, were eliminated or cut sharply. The most important were:

–Project *Apollo,* the three-man spacecraft, given $29.5 million for in-house studies and research on radiation shielding problems. Eisenhower rejected a NASA proposal to begin hardware R&D.

–Project *Rover,* the nuclear rocket engine development program, given $2.6 million in the supplemental and about $14 million in '62. The supplemental will allow NASA to choose a prime contractor this spring and put the contractor to work in support of engine work at the Los Alamos Scientific Laboratory of the Atomic Energy Commission. However, neither the supplemental nor the '62 budget contains funding to pay for development of nuclear rocket-engine hardware.

The budget cuts are reflected in Glennan's stretchout of the first flight test of the *Rover* engine from 1965 to the 1966-67 period. In fact, an official close to the program said, the level of funding does not even provide for meeting the stretched-out schedule.

–*Saturn* S-II stage, an 800,000-lb.-thrust cluster of four Rocketdyne J-2 liquid hydrogen engines, which will be the second stage of the second-generation *Saturn,* designated *C-2.* NASA had announced plans to hold a bidders' conference in May or June 1961 and award a contract to begin R&D on the stage early in 1962.

The S-II stage status in 1962 is similar to that of Project *Rover* in 1961. A relatively small, but unspecified, amount is provided to begin work with a contractor late in the fiscal year.

• **Mercury still top priority**—Project *Mercury* comes in for $74.245 million, a decrease of $35 million from '61. This does not represent a cutback, however, since it was anticipated from the start that *Mercury* would reach its spending peak in FY '61. NASA budget briefers said *Mercury* is still "fully funded" and assumes continuation of the DX priority—the nation's highest.

*Mercury* and *Apollo* together total $103.745 million, a decline of $7 million for manned space flight from 1961. Budget briefers denied, however, that the total is not an indication of the total effort for manned space flight. They said work on the *Saturn* booster and life science research also should be considered and those two items are rising.

The total cost of developing *Saturn,* carried in several NASA accounts, will be about a quarter-billion in '62, which budget briefers voiced hope will be the peak year.

• **Stress on communications**—Communication satellites were the biggest item in the $49 million supplemental '61 request. NASA wants to spend $24 million this year, mostly to begin an industry development program on the Project *Relay* active repeater satellite. Some of the money will go toward developing a bigger—140-ft.-diameter—*Echo* balloon satellite of somewhat stiffer material. Two additional *Delta* vehicles and two additional *Atlas-Agena* vehicles are to be procured for boosting communications satellites.

The '62 budget is to include $44.6 million for communications satellites, compared with $3.912 in '61, almost all of which went for Project *Echo.* The budget assumes receipt of $10 million from private industry as a fee for procuring and launching rockets to test a privately owned active communications satellite.

Other items in the supplemental are:

–$16.18 million to procure additional *Centaur* vehicles.

–$5 million for long lead-time costs, mainly down payment on a booster, for the Project *Mariner* interplanetary spacecraft to be flown next year.

–$1.825 million for uprating the third and fourth stages of *Scout,* the so-called *"Super Scout."*

–$2.6 million for Project *Rover.*

The budget provides $476,000 in staff salaries and $8.62 million in research grant money to be let by a new life sciences laboratory to be established at NASA's Ames Research Center at Moffett Field, Calif. The budget provides $6.38 million in construction at Ames, much of which is for the life sciences center.

The center came into existence Feb. 1, and will gradually grow to a staff of about 60 scientific people and 140 supporting technicians, NASA said.

• **Other cuts**—Deleted from the budget, apparently by Eisenhower, was a proposal by Jet Propulsion Laboratory to build the first of three 250-ft. antennas for its Deep Space Instrumentation Facility.

These other items, sought by groups within NASA, were deleted either before the budget left the space agency or afterward:

–Project *Aeros*—Study or R&D of a 24-hour stationary weather satellite equipped with Zoomar TV lenses for closeups of hurricanes and other major storms.

–R&D on a large solid-propellant launch vehicle as a backup for *Saturn.*

–A third *Saturn* launch complex at Cape Canaveral, to provide capability of multiple launchings in support of rendezvous operations.

–Parallel development of a *Rover* nuclear vehicle stage, in addition to engine development. ‡

# HOW YOU CAN PUT TELEVISION TO WORK

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Today, hundreds of companies are solving a wide variety of business and industrial problems with KIN TEL closed circuit TV systems.

*For example:*

U. S. Steel uses a KIN TEL system to see inside open hearth furnaces.

The Los Angeles Department of Water and Power uses one for remote viewing of water-level meters.

Convair, Douglas, Lockheed, and Northrop all watch rocket tests with KIN TEL systems.

Westinghouse watches nuclear power reactor tests with one.

American Potash and Chemical monitors conveyor line and warehousing operations with one.

The San Francisco Naval Shipyard uses one to guard against pilferage.

These, and many other KIN TEL customers—both large and small—have discovered a significant fact: *Closed circuit television is no longer a novelty.* It's a proven, practical piece of equipment that, in many instances, pays for itself within a year. It's a modern, money-making piece of equipment that you can use in your business, in your plant, in your operation.

## What Is a Kin Tel Closed Circuit TV System?

The basic system manufactured by KIN TEL consists of a rugged yet sensitive camera that is small enough to hold in your hand; a receiver that displays pictures that are twice as sharp as you can get on your home TV set; and a camera control unit that is so automatic the only control you have to touch is the on-off switch.

## More Than Likely, Your Business Can Use Such a System.

**You can use one to watch events or operations that are tedious, difficult, dangerous, or even impossible for men to watch.**



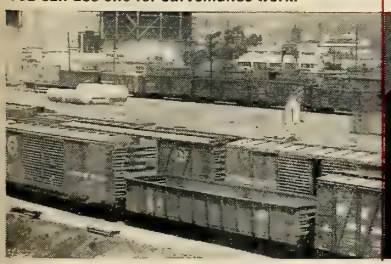
Dependable KIN TEL TV systems see where men cannot survive; withstand tremendous extremes in temperature and pressure; perform both critical and routine jobs inexpensively, faultlessly, safely, tirelessly.

**You can use one for data transmission.**



All types of visual information–from blueprints to fingerprints to graphs–are transmitted over great distances quickly, accurately. Such systems save money, reduce errors and confusion, speed operations.

**You can use one for surveillance work.**



KIN TEL cameras scan vast areas; guard valuable equipment and property; never blink, quit, sleep, or make an error; watch many operations at once; transmit all information to a central monitoring point.

**You can use one for on-the-job training.**



Students study operations viewed by a KIN TEL camera. Such systems permit mass teaching that gives each student an unobstructed view; provide on-the-spot realism; end expensive, disturbing plant tours.

## Here's What a Kin Tel System Can Do for Your Business

It can do what it is doing, right now, for hundreds of other firms. It can increase the over-all efficiency of your entire operation. It can help you tighten production and inventory controls, help you better your services to customers and clients. It can reduce errors and confusion and duplication. It can cut costs. It can save you time and money. It can free valuable men from tedious and routine tasks. It can give you the modern tools you need to keep pace in this highly competitive market.

For a more specific analysis of how KIN TEL TV can go to work for you, write direct for catalog 6-103 and the name of your nearest KIN TEL engineering representative.

## 8 Reasons Why So Many Firms Insist on Kin Tel TV Systems

**1. Reliability.** KIN TEL equipment is designed to keep working, day in and day out. It's the first choice for ICBM and other missile programs that depend on TV, that can't afford to compromise with reliability.

**2. Picture Quality.** Full 650-line resolution provides maximum delineation, essential for qualitative observation of complex operations, and for transmission of printed material.

**3. Automatic Operation.** KIN TEL TV is the only closed circuit system that provides entirely automatic, through-the-lens compensation for light-level changes of several thousand to one.

**4. Sensitivity.** With KIN TEL equipment, the light needed to read this page is enough for sharp, clear pictures; and usable pictures can be provided with less than one foot-candle illumination.

**5. Ease of Installation.** No site preparation is needed, no interacting electrical adjustments are required. All units fit in standard 19-inch racks.

**6. Simplicity of Operation.** With no changes in lens iris to make, the only thing the operator has to know is the location of the on-off switch.

**7. Adaptability.** A complete line of shelf-item system components and a variety of cameras and monitors permit observations of nearly every kind of operation, under all kinds of conditions.

**8. Application Help.** You don't have to waste your money and time on application engineering. At no obligation, KIN TEL's nationwide factory-trained field engineers will determine whether or not a TV system can be put to profitable use in your intended application.

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC

5725 Kearny Villa Road, P.O. Box 623, San Diego 12, California, BRowning 7-6700

*KIN TEL—pioneer and leader in closed circuit television*

Circle No. 4 on Subscriber Service Card.

# —contracts—

## NASA

$3,000,000—**Packard Bell Electronics Corp.**, Los Angeles, for an automatic checkout system for the *Saturn* space vehicle booster.

## NAVY

$1,012,559—**Del Mar Engineering Laboratories**, for expendable high-performance tow targets.

$500,000—**Atlantic Research Corp.**, Alexandria, Va., for an auxiliary rocket of advanced design for the *Polaris* system. Subcontract from **Lockheed's Missile Systems Division.**

$350,000—**Perkin Electronics Corp.**, El Segundo, Calif., for power supplies to be used in shore support and on-board submarine launching of the *Polaris* missile.

$286,000—**Bulova Watch Co.'s Electronics Div.**, Woodside, N.Y., for frequency control devices for the command guidance system of the *Bullpup* missile. Subcontract from **The Martin Co.**

## AIR FORCE

**Bell Aerosystems Co.**, Buffalo, N.Y., for studying the feasibility of building a visual space flight simulator to prepare astronauts for what they will see when they actually get out into space. Amount not disclosed.

$2,125,861—**Pacific Semiconductors**, for delivery of ultra-high-reliability silicon computer diodes to be used in *Minuteman* production. Subcontract from **Autonetics Div., North American Aviation, Inc.**

$2,000,000—**Baird-Atomic, Inc.**, Cambridge, Mass., for a reliability testing program in connection with the *Midas* satellite program. Subcontract from **Lockheed's Missiles and Space Division.**

$600,000—**The Electronics Div. of Chance Vought**, Dallas, for electronic test equipment for the *Titan* missile. Subcontract from **AC Spark Plug Div. of General Motors Corp.**

$512,000—**The Martin Co.**, Baltimore, for *TGAM-83* guided aircraft missiles and related support items.

$400,000—**Perkin Electronics Co.**, El Segundo, Calif., for special power supplies for *Titan* missile ground support equipment.

$200,530—**Boeing Airplane Co., Aero-Space Div.**, Seattle, for technical data applicable to the *IM99A* and *IM99B* missiles. Five contracts.

## ARMY

$11,500,000—**Sperry Gyroscope Co., a division of Sperry Rand Corp.**, Great Neck, N.Y., for the development and construction of high power transmitters for the discrimination radar system of the *Nike-Zeus* missile system. Subcontract from **Bell Telephone Laboratories.**

$6,000,000—**Convair, Div. of General Dynamics Corp.**, Pomona, for initial development of the *Mauler* guided missile system.

$3,000,000—**Columbia University**, New York City, for analysis of radar noise in the *Nike* and related systems.

$2,972,288—**Radioplane Div., Northrop Corp.**, Van Nuys, Calif., for target missiles.

$2,545,262—**Collins Radio Co.**, Cedar Rapids, for construction of facilities for *Minuteman* missiles at Vandenberg AFB.

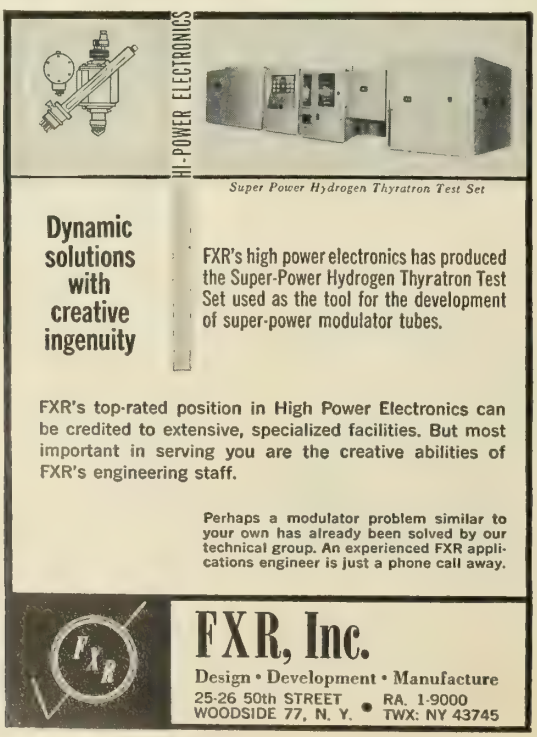
$1,437,106—**Sperry Rand Corp.**, Salt Lake City, for repair parts for the *Sergeant* missile system. Four contracts.

$368,000—**International Builders of Florida, Inc.**, Coral Gables, for construction of an addition to a missile assembly building at Cape Canaveral.

$339,992—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* missile ground handling equipment. Two contracts.

## MISCELLANEOUS

$830,000—**Sanders Associates, Inc.**, Nashua, N.H., for subminiature rate gyros. Subcontract from **North American Aviation's Autonetics and Convair.**



# —when and where—

## FEBRUARY

**Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components (unclassified), South Texas Section of SNT and Southwest Research Institute,** Gunter Hotel, San Antonio, Feb. 14-16.

**Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting,** Sheraton Hotel and University of Pennsylvania, Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, La., Feb. 26-Mar. 1.

**Armed Forces Management Assoc., Annual National Conference,** Shoreham Hotel, Washington, D.C., Feb. 28-Mar. 2.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

## MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.

**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

**Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, co-sponsored by IRE (PGNS), AIEE, IAS,** University Museum, Philadelphia, Mar. 9-10.

**Institute of the Aeronautical Sciences Flight Propulsion Meeting, (classified),** Cleveland, Mar. 9-10.

**American Rocket Society, Test Operation and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

**American Society of Mechanical Engineers, Aviation Conference,** Statler Hotel, Buffalo, N.Y., Mar. 13-17.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

**Fifth National Conference on Aviation Space Education,** Mayflower Hotel, Washington, D.C., Mar. 16-18.

**American Congress on Surveying and Mapping and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 19-25.

**IRE International Convention,** Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 20-23.



Circle No. 8 on Subscriber Service Card.

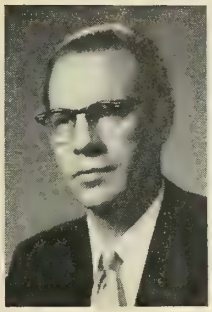
# names in the news



TALLENT



MAGINNIS



JACKSON



MILLER



KINZEL

**William P. Maginnis:** Former vice president of IT&T Component Division and president of Kuthe Laboratories, joins Maxson Electronics Corp. as vice president, research and development. Prior to joining IT&T in 1951 he served for 21 years with the Radio Corp. of America.

**Frank G. Chambers:** Elected chairman of the Board of Directors at Hazleton-Nuclear Science Corp., succeeding **Eugene M. Zuckert,** now Secretary of the Air Force. Chambers continues as president of the Continental Capital Corp. and of Maydwell & Hartzell, Inc.

**Edward H. Heineman:** Elected to the board of directors of Summers Gyroscope Co. Prior to joining the firm as executive vice president last year, he served as corporate vice president of the Douglas Aircraft Co.

**Dr. Burton F. Miller:** Vice president and director of advanced technical planning for Thompson Ramo Wooldridge Inc. has received a three-year extension of his appointment to the Scientific Advisory Board of the United States Air Force.

**Dr. Augustus Braun Kinzel:** Vice president-research of Union Carbide Corp., elected to the board of trustees for The American Optical Co. He is also a member of the Defense Science Board, Office of the Secretary of Defense; member of the Naval Research Advisory Committee; member of MIT Corp.; chief consultant in metallurgy to Los Alamos Laboratories, Argonne Laboratories and Oak Ridge National Laboratory.

**Dr. George F. Huff** and **J. S. Bardin:** Elected vice presidents of Callery Chemical Co. Dr. Huff heads the company's research and development and Mr. Bardin is in charge of manufacturing.

**C. M. Aker:** Named vice president-engineering for International Telephone & Telegraph Corp.'s Industrial Products Division.

**James B. Williams:** Vice president of Electronic Communications Inc., and general manager of its St. Petersburg Division, elected a director. Prior to joining the firm in 1960, he was for 17 years with Philco Corp. as director of weapons systems engineering and chief engineer for communications.

**Col. Charles G. Patterson:** Former director of special weapons in the Army's Office of Research and Development, appointed vice president, planning and development, by Breeze Corporations, Inc.

**Frank A. Gunther:** Executive vice president and general manager of Dynamics Corporation of America's Radio Engineering Laboratories, Inc., promoted to president.

**Robert L. Hirsch:** Formerly manager of Aerojet-General Corp.'s Washington, D.C. office, appointed assistant to the vice president, Solid Rocket Plant.

**Dr. George F. Floyd:** Elected vice president, systems research for The Bissett-Berman Corp. Prior to joining the firm, he served as a senior staff member of Ramo-Wooldridge.

**Burl H. Ervin:** Former assistant director of applications engineering, appointed director of applications engineering for the Systems Support Dept. of Nortronics, a division of Northrop Corp.

**Willard F. Bates:** Named director of manufacturing for the new Data Recorders Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

**Richard Farish:** Appointed manager, industrial engineering department of Perkin Electronics Corp. Was formerly in industrial engineering with Ryan Electronics, Northrop Aircraft and Douglas Aircraft.

**George R. Tallent:** Appointed program manager of the Motorola-Autonetics *Minuteman* Reliability Program, responsible for overall program direction and administration, including coordination of the Engineering, Production, Quality Control and Marketing Dept. Prior to joining Motorola, he was manager of Quality Control and Reliability for CBS-Electronics semiconductor operation.

**Dr. Warren N. Arnquist:** Missile and space research physicist, appointed assistant to the director of advanced research for the Douglas Aircraft Co. Was formerly assistant director of engineering research with the Systems Development Corp.

**Eugene A. Jackson:** Joins Astrosystems, Inc., as chief scientist for advanced research. He was formerly associated with Barnes Engineering Co., where he developed the electro-optical equipment used in *Tiros II*.

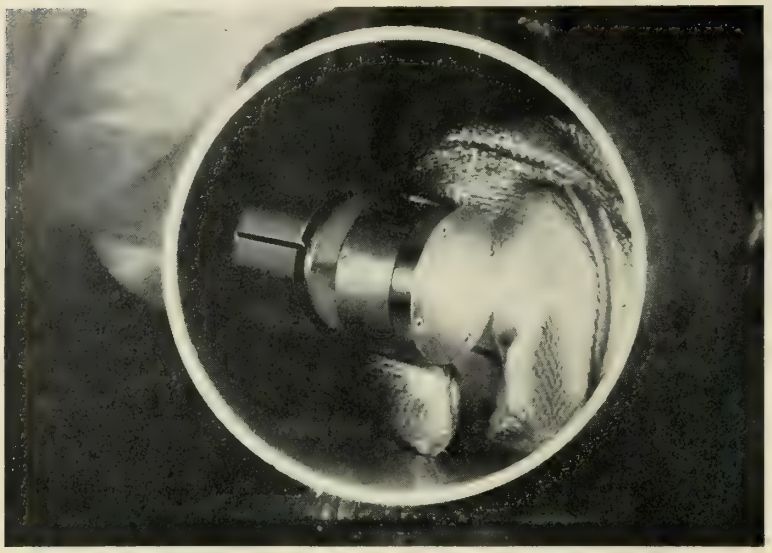
**J. L. Clark:** Appointed manager of the Ballistic Missile Early Warning System program at the Systems Engineering and Management Operation of Sylvania Electric Products, Inc.

**Dr. Kenneth Mortenson:** Former research physicist with the General Electric Co.'s Research Laboratory, joins Microwave Associates, Inc., to head a research group working on active solid-state microwave devices.

**Dr. Gaelen L. Felt:** Joins Germeshausen & Grier, Inc., as manager of the firm's Las Vegas operations. Was formerly associated with Space Technology Laboratories as staff physicist in the Vehicle Department Laboratory concerned with the application of nuclear rocket engines for missiles and space vehicles.

**C. Henry Still:** Named director of information services for The Martin Co.'s Baltimore division, succeeding **Fred E. Hamlin,** advanced to the newly-created post of corporate director of communications operations.

**Dr. L. Edward Godycki:** Former associate chemist with I.B.M. Research Laboratories, joins Electro-Optical Systems, Inc., as a senior research physicat in the company's Solid State Division.



## Small Arc-Plasma Spray Gun

A KW arc-plasma hand spray gun less than 2 in. long and 1.5 in. in diameter is available from the Plasmadyne Corp.

The plasma tool weighs less than 1 lb. and makes possible the spraying of materials onto surfaces previously deemed inaccessible due to the size of the plasma gun. The gun attains an operating efficiency greater than 60%. This represents the conversion of electrical energy to heat.

The spray gun can be used with standard Plasmadyne consoles and carries a 200 hour electrode life guarantee when used with argon. Other Plasmadyne arc-plasma spray guns are manufactured in 40 and 60 KW power levels.

Circle No. 225 on Subscriber Service Card.

## Modified Polybutadiene

A modified polybutadiene polymer with a unique combination of properties is available from B. F. Goodrich Chemical Co. Called Hycar 1000X145, the polymer has excellent abrasion resistance and will not become brittle even at temperatures as low as –85°F. It also has moderate resistance to the effects of fuels, solvents and chemicals.

The polymer's excellent electrical properties and ozone resistance make it an ideal material for use in the electrical wire and cable field. The use of Hycar 1000X145 in wire and cable applications could eliminate the need for different materials for use in the primary insulation and the protective sheath.

Circle No. 226 on Subscriber Service Card.

## Flash Power Course

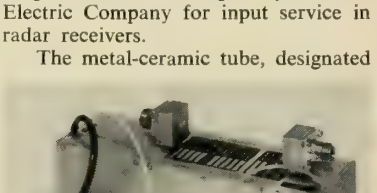
American Speedlight Corp. has available stock equipment to power electronic flash tubes. Ascorlight electronic flash equipment ranges from 0.6 duration in microseconds up to 500 million peak beam candle power. This eliminates the need for organizations investing costly man hours in designing and constructing this type of energy discharge equipment. And even if custom equipment is required, Ascor's use of standard components keeps cost down.

Circle No. 227 on Subscriber Service Card.

## Traveling Wave Tube

A low-noise traveling-wave tube for use in the 7-to-11 kmc frequency range has been developed by General Electric Company for input service in radar receivers.

The metal-ceramic tube, designated



Z-3103, has a noise figure less than 10 db, minimum gain of 25 db, and power output of 5 milliwatts across the entire band. It has been tested successfully to withstand shock at 50 g's and vibration at 5 g's.

Circle No. 228 on Subscriber Service Card.

## Spat Transistors

Philco Corp. is marketing Silicon Precision Alloy Transistor (SPAT) produced by a unique strip alloy technique, making possible unprecedented product uniformity.

SPAT transistors feature high beta, very low saturation voltage, and high emitter base diode voltage ratings.

Circle No. 229 on Subscriber Service Card.

## Quick-Connect Coupling

Jack & Heintz, Inc. is producing new design for no-air inclusion type quick-connect couplings.

Tradenamed TRIGGER LOCK and coded Series 17, these couplings form a complimentary line to the Series 10 and 11 Roto Lock couplings.

TRIGGER LOCK is aimed specifically at those applications calling for minimum leakage on disconnect, and minimum entrapment of air or other foreign matter on connect. The coupling brings improved space, weight and performance advantages to the user including: smaller size, lighter weight, faster, automatic "push pull" action for coupling and uncoupling, higher reliability over a broader temperature range, lower pressure drops and longer service life.

Circle No. 230 on Subscriber Service Card.

## Load Cell Calibrator

A Load Cell Calibration System for missiles is available from Gilmore Industries, Inc. The Model 256 is a highly accurate instrument for calibrating load cell transducers. The system calibrates from 5,000 lbs. to 1,000,000 lbs. within 0.05% of reading by using three overlapping sets of Gilmore M-170 Force Calibrators. The press is hydraulically operated and arranged to handle tension and compression loads with a stroke opening from 0 to 96 in. By a unique method of utilizing the 110,000 lbs. of dead weight at N.B.S. this system is a one-step transfer to a secondary standard.

Circle No. 231 on Subscriber Service Card.

## Adjustable Micro Switch

Adjustable differential travel is a feature of a basic switch (10BS210) available from the Micro Switch division of Minneapolis-Honeywell.

A knurled wheel on top of the switch permits differential travel adjustment from 0.0025 to 0.007 inch. Changing the differential travel changes the contact break distance, the pretravel distance and the operating and differential forces. The operating force varies from 12 to 32 ounces and the differential force from 2 to 15 ounces. The release force, however, remains at 10 ounces, regardless of the differential setting.

Circle No. 232 on Subscriber Service Card.

## High Accuracy Resolvers

Kearfott Division General Precision, Inc. has introduced the Z5153-004, Z5163-001, and Z5193-001 Size 28 high accuracy resolvers whose maximum error from electrical zero does



not exceed 20 seconds. In addition to the accuracy inherent in these components, they have the advantage of high versatility, since the same basic design permits their function as four-wire control transmitters, control differential transmitters, and control transformers. In a typical data transmission system, a string of three such components is coupled together to perform a desired function, with a total system error that is less than 35 seconds.

Circle No. 233 on Subscriber Service Card.

## Micro Micrometer

A tiny micrometer that measures width dimensions is available from Navan Products, Inc.

The model permits direct measurements of internal groove and land widths in bores as small as a 0.25 in. diameter. The instrument can be used to check workpieces without the necessity of removing them from the machine.

Direct-measuring internal-width micrometers replace as many as six different conventional measuring devices formerly required to set up and check under-cut machining operations.

Circle No. 234 on Subscriber Service Card.

## Computer Delay Lines

IMC Magnetics Corp., Gray & Kuhn Division, is marketing modular type electromagnetic delay lines which by means of their internal construction may be gauged for printed circuit board applications.

Specified as Series DL-251, these units are constructed on non-nutrient, flame retarding, plastic materials. Impedances range from approximately 300 to 600 ohms with delay times of .1 to .8 microseconds available. Dimensionally the units are .625 in. wide and run from 2 to 4 in. in length.

Circle No. 235 on Subscriber Service Card.

## Operational Amplifier

George A. Philbrick Researches, Inc. has available an all-solid state Differential Operational Amplifier, Model P2. Containing neither tubes nor mechanical choppers, it is a true dc differential amplifier whose input is entirely "floating" and yet has a long term drift stability in the sub-millivolt region. Its typical input current is well under a tenth of a millimicroampere, thus making possible its use in long time-constant integrating circuits using small polystyrene capacitors ($R = 10M$, $C = 0.1$ uf for a 1 second integrator), or its use in electrometer type amplifier circuits.

Circle No. 236 on Subscriber Service Card.

## Mylar Miniature Capacitor

Efcon, Inc. is marketing series of Mylar Miniature Capacitors, Types MH, MC, and MW.

These Efcon Mylar Miniatures operate in a temperature range of from –60°C to 125°C and tolerances of 125°C. Tolerances of ±20%, ±10%, ±5%, ±1% are available from standard production. Voltages range from 100 to 600 volts.

Two types, MH and MHH, are hermetically sealed in metal cases with glass-to-metal end seals. Type MC is a cardboard tubular, and Type MW is enclosed in Mylar tape with epoxy resin and seals.

Circle No. 237 on Subscriber Service Card.

## Molten Metal Valves

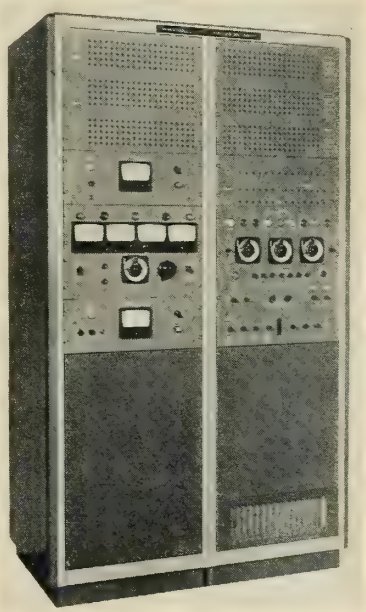
A bellows-actuated poppet valve capable of functioning in systems handling molten lead, molten sodium or molten sodium alloys at temperatures up to 500°C has been developed by Hydrodyne Corp. for applications in chemical metallurgical, nuclear, and missile fields.

Featuring finely machined bellows and heliarc welded construction of Inconel-X, the valve can operate over a range of –430°F to +1500°F at up to 450 psi. The pressure rating in other models extends to 10,000 psi.

Circle No. 238 on Subscriber Service Card.

## Automatic Analyzer

Associated Research, Inc. has available a high voltage automatic circuit and cable analyzer. The Model 8524 Analyzer embodies facilities for completely automatic continuity, insulation resistance and dielectric strength test-



ing of cables with up to one hundred and twenty conductors.

This analyzer will even completely check itself and indicate any point of malfunction. Pressing a single button causes the instrument to initiate an automatic program, testing every light, timer, meter, relay and circuit in the complete assembly.

Circle No. 239 on Subscriber Service Card.

## Automatic Sweep Drive

A sweep drive which automatically sweeps oscillators and other tunable devices through their frequency ranges is now available from Hewlett-Packard Co. Model AC-97C has two sweep speeds and a neutral. The fast sweep covers the frequency spectrum rapidly while the slow sweep gives a high resolution plot. Sweeps can be reversed automatically when limits are reached,

thereby providing a continuous sweep for oscilloscope presentations, or, for convenience in X-Y recordings, the sweep can be stopped automatically when the limit is reached.

Circle No. 240 on Subscriber Service Card.

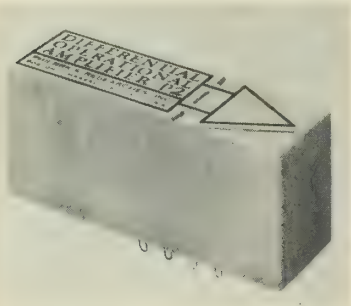
## Servo Accelerometer

A variable range servo accelerometer is available from Palomar Scientific Corp. Model PAV-1S features a closed loop servo design for exceptional accuracy and stability and high sensitivity with threshold resolution of better than 1 part in 100,000. The accelerometer permits on-site selection of full scale range by means of a readily accessible adjustment. Any desired full scale range may be selected without changing output impedance or full scale output voltage.

Circle No. 241 on Subscriber Service Card.

## Operational Amplifier

An operational amplifier is available from Donner Scientific Co. The solid state amplifier, Model 3801, uses silicon transistors throughout to provide both



the high gain, wide bandwidth path and the chopper stabilization path. In standard form, the Model 3801 will operate over a temperature range from 0°C to 55°C in a relative humidity of 95%. It will withstand shock of 30 G and meet all specifications to an altitude of 50,000 feet.

Circle No. 242 on Subscriber Service Card.

# new literature

BALL BEARINGS—Cleaning and relubricating equipment for ball and roller bearings is the subject of a brochure published by Bearing Inspection, Inc. The described equipment will handle bearings ranging in size from ¼ in. to 14 in. OD, and it will clean most bearings with the shields in place.

Circle No. 200 on Subscriber Service Card.

D-C POWER—Bulletin GEA-6690A, listing the features, operation and applications for custom-built D-C power supplies for computers, aircraft, missiles, military and special applications is available from General Electric Co. Publication included photographs, load current graphs, and a comparison table of relative characteristics of different types of power supplies and power supply systems.

Circle No. 201 on Subscriber Service Card.

DIGITAL VOLTMETERS—A Pocket Guide to the Proper Selection of Digital Measuring Instruments, from Non-Linear Systems, Inc. The guide answers such questions as: What are the practical applications of digital measuring instruments? and How important is servicing in selecting a digital voltmeter?

Circle No. 202 on Subscriber Service Card.

GOLD ALLOY PREFORMS—Technical Bulletin Z-108 describing gold alloy preforms for use in semiconductor processing is available from Accurate Specialties Co., Inc. Bulletin Z-108 offers semiconductor engineers information on the use of gold alloy preforms for two applications—as a joining material to produce an ohmic junction, and when doped with N or P type elements, as an alloy junction material.

Circle No. 203 on Subscriber Service Card.

VARIABLE PHASE STANDARD—A brochure published by Gertsch Products, Inc. describes a variable phase standard which permits phase between 2 self-generated voltages to be shifted to any desired angle with an accuracy of ±.05° or better. A front panel switch allows operation at any of three fixed frequencies within the range of 150 to 3000 cps. Included are technical specifications, a detailed circuitry description, and a simplified block diagram.

Circle No. 204 on Subscriber Service Card.

PLASMA SPECTROGRAPH—A Plasma Research Spectograph for use in plasma diagnostics and high temperature gas research is described in a pamphlet available from Bair-Atomic, Inc. Featuring a 15,000 lines-per-inch 3-meter concave grating and modified Eagle mounting, the B/A instrument facilitates spectrochemical analysis of plasma and permits determinations of relative spectrum line intensities, Doppler and Stark broadening profile curves, continuum measurements and target ablation studies.

Circle No. 205 on Subscriber Service Card.

BALL VALVES—A design and product data file, containing descriptions of ball valves for handling cryogenic fluids, high-pressure gases and water, large propellant flows, hazardous chemicals and petroleum products, is available from The Vickery Co.

Circle No. 206 on Subscriber Service Card.

# —letters

## Wilson's Is Blue

*To the Editor:*

The Dec. 5 M/R carried a fine article about Air Force General (Roscoe C.) Wilson. However, I noted what I believe was an error in the description of General Wilson's fourth-floor Pentagon office. The article stated "Behind Wilson stood his red and white three-star flag."

Unless General Wilson is using a 3-star flag of the U.S. Army or the U.S. Marine Corps, the flag would have white stars on an ultramarine *blue* field with gold fringe. This latter design was authorized for Air Force General Offices shortly after the Unification Act of 1947, creating a separate Department of the Air Force and the United States Air Force.

This is a minor type of error and in no way detracted from the excellence of the article, which I am quoting from heavily when instructing our Cadets here at Michigan Tech.

Robert F. Schirmer
Colonel, USAF
Professor of Air Science
Michigan College of Mining and Technology
Houghton, Mich.

*You're correct.—Ed.*

## Shoot, You're Faded

*To the Editor:*

Please count me among the first to defend your right to editorialize, and mine to criticize. I bristled a little over your statement in the Jan. 2 M/R editorial that "We have had, actually, not a space program but a space wrangle." I happened to read this just after reading your fine resumé on page 29 of the same issue showing that we had 20 satellites in orbit to two for the Soviets. I bristled a little more over the comment of John Savas (Letters, M/R Jan. 9, p. 48) concerning the "militarists" in the Pentagon, the "military dictatorship," H-bombs and shelters; in fact, you name it and he knew all about it. Disraeli summed it up better than I could when he said, "This shows how much easier it is to be critical than to be correct." Then, upon turning the page, there in bold, black letters was your (editorial) "Military Dogma Fades Slowly, Too." What did the "too" mean? Does civilian dogma fade slowly; does military dogma do other things besides fade slowly; or does all dogma fade slowly? Shouldn't it? Webster says that dogma is, "That which is held as an opinion, esp., a definite tenet; also, a code of such tenets." The only synonym listed is doctrine. Do you want doctrine here today and gone tomorrow?

Where you really missed the point is in associating the "layers of indecision and inaction" in the Pentagon corridors, with the action that will take place when the President presses the "go" button. The "go" circuit does not run through the "layers of indecision and inaction" in the Pentagon corridors. You might just as well close up the Pentagon as the

Operational Commanders are on their way . . .

I'll say one thing, you show no favoritism—witness your "The rigidity of the military mind has its counterpart in the civilian . . ." It seems to me that a man of your position, prestige, influence and education should be a little more careful in the use of the English Language and a little less dogmatic in attitude.

Gregory K. Gregory, Jr.
Newport, R. I.

*"Military Dogma Fades Slowly, Too" was an allusion to the familiar song, "Old Soldiers Never Die, They Just Fade (Slowly) Away" ("slowly" being our insertion); which seems clear enough. The rigid military and civilian minds referred to are, obviously, some of the minds in and out of uniform which direct our military policy; we resent (as only an editor can) being taken out of context. —Ed.*

## Right Stater

*To the Editor:*

Your attention is invited to a correction of the report of an Army contract in M/R, Jan. 16. The Hardaway, Oman, Farnsworth & Wright joint venture trading as Midland Constructors is from Columbus, *Georgia,* not Ohio as reported.

Please send me five reprints of "The Energy Level of Things" and ten reprints of the "Special Report on Titan" from your Sept. 5, 1960 issue.

This office and its staff really leave your magazine "dog eared" as it is passed around. They read everything and wish the publication were larger.

Arthur R. Simpson, Major, CE
Liaison & Briefing Officer
Army Corps of Engineers Ballistic
Missile Construction Office
Little Rock AFB, Ark.

## Moon Colony Now?

*To the Editor:*

The article "Solar Flares Pose a Problem" (M/R, Jan. 9, 1961) underlines the importance of immediate colonization of the moon.

"Not only will the moon itself provide adequate radiation shielding, especially in the polar regions, but it is 20 times easier and cheaper to lift a given weight off the moon than off the earth. It would be almost infinitely easier to obtain the necessary shielding material from Deimos (the outer satellite of Mars) once we are there, but shielding will be needed on the way to that satellite, so we will in practice be limited to the moon for a beginning. The difficulty and expense of placing a man on the moon may be formidable, but they are nothing compared to those of sending up 5000 lbs. of shielding material for each person from the earth.

Insufficient attention has been given to the possibility of devising primitive survival techniques to enable men to live on the moon with a minimum of equipment from the earth. All the chemical elements needed to support life are present on the moon, and the more immediately needed ones can probably be extracted by the use of solar heat more easily than on earth, owing to the possibility of heating large areas by the use of large mirrors and absorbers made of extremely light metal foil. Certain polar craters probably contain adsorbed gases capable of being freed at temperatures below the boiling point.

Theodore B. Dufus
Los Angeles

## Air Mailing Appreciated

*To the Editor:*

I was very glad about your decision to deliver MISSILES AND ROCKETS to your European subscribers by air mail. Let me say how much I appreciate this new service. I, personally, here in Munich now have M/R on hand one or two days after the magazine is dated. So I am able to get the latest information brand-new—a fact which is very important for a newspaperman 4000 miles away from the missile plants and spacecraft launching areas.

I first learned of your magazine in the spring of 1958, on a trip through the United States, and have been a subscriber ever since. Let me take the opportunity to point out how indispensable M/R has become to me.

Otto Merk
Munich, Germany


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### Advertisers' Index

AC—The Electronics Div., Gen. Motors Corp. .... 51
Agency—D. P. Brother & Co.

Aerospace Corp. ..... 20
Agency—Gaynor & Ducas, Inc.

Ampex Data Products Co. ... 8
Agency—Boland Associates

Autonetics, a Div. of North American Aviation, Inc. ... 19
Agency—Batten, Barton, Durstine & Osborn, Inc.

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Agency—Anderson-McConnell Adv. Agency, Inc.

Cohu Electronics, Inc.—Kin Tel. Div. ..... 43
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Donner Scientific Co., a Sub. of Systron Donner Corp. .. 52
Agency—Bonfield Assoc., Inc.

FXR, Inc. ..... 44
Agency—Beecher Assoc.

Lockheed Aircraft Corp., Missiles & Space Div. ..... 29
Agency—Hal Stebbins, Inc.

Martin Co. ..... 39
Agency—Ketchum, MacLeod & Grove, Inc.

Monsanto Chemical Co. . . 2, 3, 4
Agency—Gardner Adv. Co.

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# Toward the New Frontiers

PRESIDENT KENNEDY has moved swiftly in his first two weeks in office. The fact that the snow-choked capital has been more reminiscent of Siberia's New Lands than America's New Frontier has not slowed him down.

His State of the Union message held encouraging news for the missile/space industry and for the nation. *Polaris* is to be stepped up drastically. The entire missile program is to be accelerated. The role of the National Aeronautics and Space Administration was slighted somewhat in the speech, but the suggestion of international cooperation in this field indicated the President does not intend to overlook it.

The prospects therefore are bright for the missile/space industry, which already has rocketed in less than a decade to a $10-billion market. Some estimates place the military missile/space market alone at $20 billion in 1970.

For this now-mature industry, the sky is no longer the limit. In space, there is literally no limit. The stars beckon.

As the new Administration charts its course, MISSILES AND ROCKETS magazine is setting out toward a New Frontier of its own under new editorial guidance. We feel that as a member of the missile/space industry you may be interested in where your magazine is going.

MISSILES AND ROCKETS intends to fulfill its role as the magazine of the missile/space industry. In the past, our critics have charged us on occasion with being a spokesman only for the Army . . . or the Air Force . . . or the Navy. To clear up any possible misunderstandings, we state unequivocally that we will be a spokesman for the missile/space industry. In most cases, the interests of the industry and the military services or NASA are parallel. Where they differ, we stand on the side of industry.

We are concerned, for example, with an increasing tendency on the part of the Air Force to drop contractor names from press releases, referring only to an AF *Atlas* or AF *Titan*. One public relations officer even voiced distress to us that The Martin Co. had referred to its product in a press release as a Martin *Titan*.

BUT LET IT ALSO be clear that we will speak FOR the missile/space industry only when, in our considered opinion, the industry is right. When it is not, we intend to fulfill our necessary role as critic and speak TO the industry.

There are several marginal programs in the missile/space industry which should have been killed some time ago. Everyone in industry knows what they are. We will support efforts to drop these programs.

You will find in the months ahead more emphasis on the third word in our subtitle: Space. Here lies the future and we will devote increasing editorial attention to it. We believe strongly that the Air Force has a military mission to fill in space and we intend to fight for recognition of that fact.

For the first time in a quarter-century, there is no bomber procurement in the new budget. We mourn the end of an era. But we hail the New Frontier of our own industry: the missile/space industry.

**William J. Coughlin**

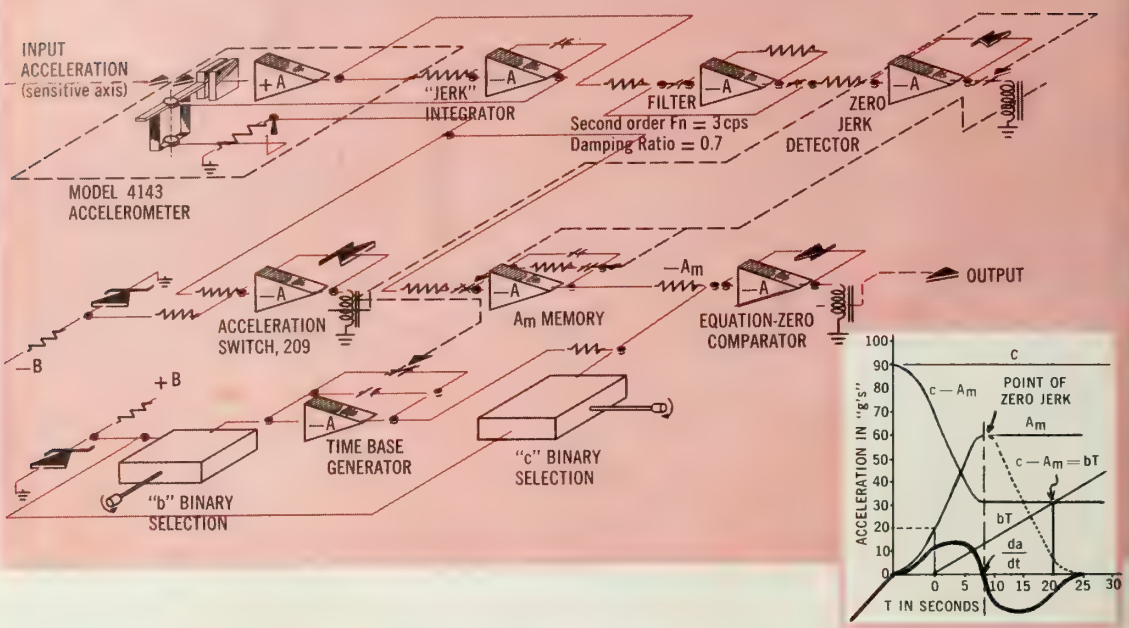
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**AC SPARK PLUG ✲ THE ELECTRONICS DIVISION OF GENERAL MOTORS**



Functional Diagram of Donner Accelerometer Timer Switch. Basically an airborne computer designed to solve a specific equation, this Donner device consists of a force balance accelerometer, whose output feeds to a jerkmeter for determination of peak acceleration (Jerk (da/dt) is the first derivative of acceleration). From the jerkmeter the signal passes through a filter and to a zero jerk detector which closes a switch at the peak acceleration. Other units in the computer are a peak acceleration memory, a 20 g acceleration switch which starts a time base generator and prevents the zero jerk detector from operating before a correct solution is possible, "b" and "c" selection binary units allow 64 values of "b" and "c" to be selected within the operating range, and an equation zero comparator which algebraically sums the output of the maximum acceleration memory circuit, time base multiplied by "b" and "c" circuit to close the relay output when $bT = c - A_m$. The curve below illustrates the equation and the fact that peak acceleration occurs at zero jerk.




# How to Solve a Flight Equation

## *New Donner Airborne Analog Computer solves equation* $bT=c-A_m$

where b = predetermined constant, T = time in seconds,
c = predetermined constant, and $A_m$ = peak acceleration achieved.

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In solving this problem, Donner engineers combined their experience with computer techniques and servo force balance accelerometers. The device illustrated is all solid state.



**Acceleration Summing Switch.** This remarkable small computer is approximately 4" high and 2½" across. The two knobs on the top are used to set in "b" and "c" constants of the equation.



**COMPLETE TECHNICAL INFORMATION AVAILABLE**
If you would like more information about this interesting application of computer and transducer techniques, our Mr. Stephen P. Cuff has prepared a technical discussion which he will be happy to send along. Please write Mr. Cuff at Donner Scientific.

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FEBRUARY 13, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

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*Minuteman's Triumphant Take-off*

Minuteman Production Rate to Double? . . 12
DOD Revising Procurement Regulations . . 16
New Family of Tape Recorders for Space . 24

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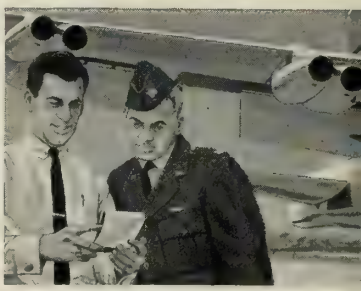
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HE MISSILE / SPACE WEEKLY

# nissiles and rockets

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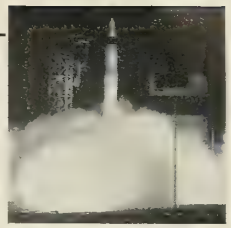
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## THE COVER

*Full-scale Minuteman blasts away from Cape Canaveral in highly successful first flight test. The Defense Department is weighing a plan to double production rate.* *See p. 12.*

## FEBRUARY 13 HEADLINES

Doubling of Minuteman Production Rate Proposed .. 12
Latest Intelligence Said to State 'Gap' Continues .... 14
Soviets Break Own Weight Record with Sputnik VII .. 15
Pentagon Begins Revision of Procurement Rules..... 16
AF Contractors Report Saving Half-billion Dollars ... 17
Uhl Named New President at Fairchild Corp. ..... 17
Zeus Production Plan Gets Strong New Support ..... 17
GE Winner of Prime Contract for NASA Nimbus ..... 18
ARS Meeting Told of Consumable Case Rocket ..... 35
Details of NASA's S-3 and S-45 Satellites ..... 40
IRE Group Notes Sparse Data on Radiation Effects .. 42

## ELECTRONICS

S-16's Tape Recorder May Set Standards for Future .. 24
AGAVE Tracking System Going Aboard Eight Ships .. 28
Bell Lab's Gaseous Laser to Swell Communications .. 38

## PROPULSION ENGINEERING*

Exclusive Interview: Lee's Plans for Astropower .... 30
NASA Picks Bidders for Saturn Tanks Contract ..... 31

## ADVANCED MATERIALS†

Callery's Experience Cuts Risks in Fuel Handling ... 34

## DEPARTMENTS

The Missile/Space Week† ..... 8
The Countdown ..... 11
Technical Countdown . 23
Contracts ..... 43
Products & Processes . 44
Names in the News .. 46
Letters ..... 47
When and Where .... 47
Reviews ..... 48
Editorial ..... 50

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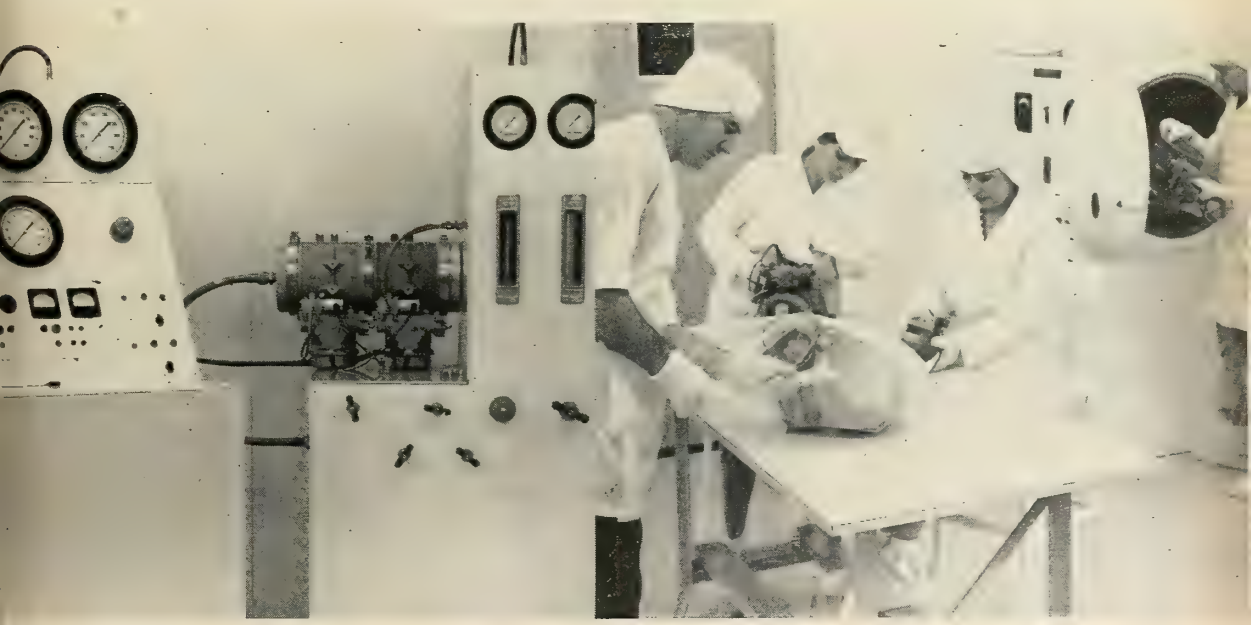
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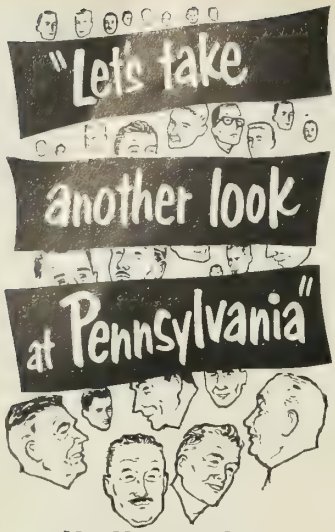


**FINAL INSPECTION AND TESTING** Again, inspections are made for contamination. Influent and effluent tests of the entire unit are conducted to spot any flaw or weakness that might possibly hinder optimal performance. The results of these tests are carefully checked by quality control personnel.

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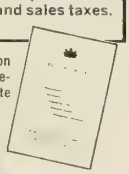
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# The Missile/Space Week

## New Segmented Rocket Test

"Huge versions" of conical segmented solid rocket may be tested soon by United Technology Corp. The company has successfully fired a 15,000 lb. thrust model with a specific impulse about the same as *Minuteman*. Segments were joined by a modified bolted flange instead of a tongue-and-groove design secured by shear pin used in two earlier tests. The three segments totaled 7 ft. in length and were 3.5 ft. in diameter.

## Polaris A-2 Fails

Within a month the Navy expects to launch another *Polaris A-2*—testing the same type of vehicle which ruptured and exploded on the pad last week. The shot was the first failure of the longer range (2500-mile) bird in four attempts with the new Hercules Powder Co. glass case.

The spectacular failure was remarkably similar to one involving a *Polaris AX-2* on Oct. 15, 1958. In both instances the second stage tore loose into the air while the first stage remained on the pad, spewing flames from both ends.

Last week, the Navy assigned construction of five new *Polaris* subs to these shipyards: General Dynamics' Electric Boat at Groton, Conn. (2); the Newport News, Va. Shipbuilding and Drydock (2), and the Naval Shipyard at Mare Island, Calif. (1). The Navy also launched a seventh *Polaris* sub—the Sam Houston.

## Centaur Launch Slips

First launch of a *Centaur* vehicle is expected to slip into the third quarter of this year as a result of an engine explosion at Pratt & Whitney's West Palm Beach, Fla., plant in mid-January. Shot had been scheduled for June 29. The explosion occurred when one engine failed to ignite and an excess of $LH_2$ and LOX was pumped into the chamber.

## NASA Tests Weightless $LH_2$

Data on heat transfer coefficients for liquid hydrogen during 5 minutes of weightlessness was obtained by NASA Feb. 5 in the 94-mile high shot of an *Aerobee 150A* from Wallops Island, Va. The 25-lb. payload contained a dewar partially filled with the liquid. Telemetry was successful but weather prevented payload recovery.

## Germans Leave Space Club

The budding European space program suffered a devastating blow last week when the West German Defense Ministry announced that Germany would not participate in such a program.

Drafters of the plan had counted on the West Germans for 18% of the estimated cost of $200 million (M/R, Feb. 6, p. 15). Great Britain, in addition to the money already spent in developing the *Blue Streak* rocket, would put up 25%, France 22%. Italy was to supply 11% and other countries less than 5% each.

Informed sources indicated that Belgium, Austria and Denmark—whose support during the Strasbourg conference was never overly enthusiastic, may follow the German lead and stay out of the joint effort.

## Capsule Weight Hush-Hush

The National Aeronautics and Space Administration declined last week to release the total weight or a breakdown of component weights in the *Mercury* capsule.

Warren North, chief of manned satellites in the manned flight section of NASA headquarters, said the Air Force objects to release of the total weight on the ground that it reflects the capability of the *Atlas*—and thus the size of its warhead.

In addition, he said, the weight information would reflect the state of the art in manned capsule design.

NASA spokesmen have said the capsule weighs slightly more than a ton. North declined to go beyond that statement.

He said that contractors with security clearance and the need to know—such as for study contracts on *Apollo*—could have the weight information on a classified basis.



*ON ONE OF HIS FREQUENT visits to industry facilities, West Coast Editor Richard van Osten confers with Aerojet-General's director of testing operations.*

# memo from the publisher

THE MAN at the left above is Dan Tenenbaum, manager of Aerojet-General's test division at Sacramento, Calif. The serious-looking gentleman on the right is a former intelligence officer who now heads up our West Coast bureau. With apologies to Dan, this is about Dick.

As many of you already know, Dick van Osten is well qualified in the missile/space field as a replacement for Bill Coughlin, who moved East to the editor's desk. Dick has been covering the industry as a member of the Los Angeles staff for the past four years.

His assignments have taken him not only to Sacramento, where the picture above was taken, but north to Boeing, south to Convair and west to military installations in Hawaii. One of Dick's most recent articles was the exclusive on optical alinement of the mobile *Minuteman* guidance package which appeared last week. You'll find his story on the IRE Winter Military Electronics meeting on p. 42 of this issue.

Van Osten was an Air Force pilot from 1943 to 1949. Much of this time he spent flying C-47's in Europe, where he met the charming Belgian girl who is now his wife. They have two children. Dick also was an instructor at the European Command Intelligence School in Oberammergau, Germany.

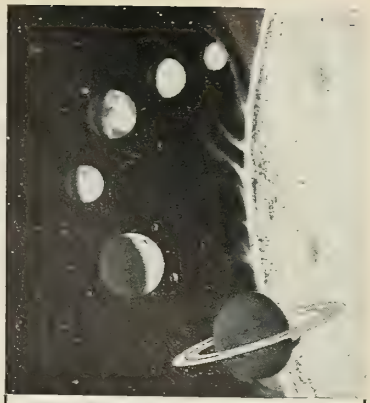
Before World War II, he worked at Douglas Aircraft Co. in the experimental department, in final assembly and as a flight line mechanic. One of his more interesting jobs after the war was on the fabled Hughes flying boat, where Howard Hughes once stepped on his hand. Van Osten later was editor of an automotive publication at Trend, Inc., now Peterson Publications. During this period, his love of race driving was combined with his knowledge of Europe in a fine series of exclusive articles from Le Mans and other racing centers on that side of the Atlantic.

Just before joining us at American Aviation Publications, Dick worked for Lockheed Field Service in California and for Frank Mayer Engineering Co. as a technical writer.

Incidentally, while Dick was busy in Los Angeles at IRE, one of his staff members, Associate Editor Frank G. McGuire, was in Salt Lake City covering the American Rocket Society solid propulsion meeting. His story is on p. 35. This kind of on-the-spot coverage enables us to bring you the important technical news of the missile/space industry as it happens, coverage valuable to you in your job.

Your appreciation of this is shown by the fact that our circulation hit an all-time high of 31,027 paid subscriptions for the January 30 issue—up some 2000 in the last six months. It also has been reflected in an all-time high in advertising billings for January issues.

Edwin S. Muhlfeld

## STRUCTURAL RESEARCH

The expanding and aggressive role we are taking in our nation's developing space program has created a demand for senior engineers and scientists with an innate curiosity about, and an intense interest in, any of the yet unexplored technological areas requiring solution. One example is the structural design and analysis of spacecraft. Some random samples of our current requirements are:

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If you are a graduate Aeronautical, Mechanical or Applied Mechanics engineer with five or more years experience in structures, and wish to broaden your experience and brighten your future, address your resume to:

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Employment Services
12214 Lakewood Blvd.
Downey, California

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**Please permit us a very free translation of the above equation.** It's "Maximum imagination plus maximum energy plus experience equals, Boeing/Wichita's requirements for experienced **structural** design, test and research **engineers**."

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# The Countdown

## WASHINGTON

### ICBM Base Speed-up Coming

Every possible means of accelerating construction of *Atlas* and *Titan* bases is being examined by the Kennedy Administration. The goal is to make up lost time and to at least tie, if not beat the old schedule. More rapid deployment of *Minuteman* is considered a strong possibility—although the first launchers have not been started yet.

### Anti-Tank Missile Shelved

The Army decision for procurement of large numbers of anti-tank missiles is being left, at least temporarily, on the shelf where it has been for the last several months. One contractor in the hot competition has already been recommended by Army evaluators. But the recommendation remains stopped in the Chief of Staff's Office.

### Budget Changes: How Many and How Much?

About $2 billion in add-ons to the final Eisenhower defense budget is the figure now expected by many Pentagon insiders. As many as 30 programs may be affected. However, the bulk of the money is expected to go to the big strategic missiles systems and Army modernization.

### $110 Million for Navy Ranges

The Navy is scheduled to spend about $100 million in FY '62 on the sprawling Pacific Missile Range. Another $10 million of Navy money is earmarked in the new fiscal year for initial work on AUTEC—the Atlantic Underwater Test and Evaluation Center which will be built in the Bahamas. In all, some 15% of the Navy's R&D budget will be spent on the two ranges.

### Lunar Orbit Stalled

Next attempt at a lunar orbit by the U.S. now appears to be at least two years away. It apparently will be with the *Surveyor* spacecraft being developed for NASA by Hughes for first flight in 1963. Lunar orbit will be an offshoot of the program to soft-land an instrument package on the moon.

### On the Pad

NASA is re-examining its launch schedule. Prime questions concern first flight of *Saturn*, which has slipped a little but may still go in the third quarter of this year, and whether to aim for a launch toward Venus with *Mariner* in August, 1962. . . . Repeat attempt of a *Scout* satellite is expected within a few days. Vehicle carrying an *S-56* air-density drag 12-ft. balloon will have a beacon antenna on the fourth stage. . . . A *Little Joe Mercury* is set for about March 1.

## INDUSTRY

### New Solid Propellant

North American's Rocketdyne Division has come up with an advanced flexible-cast propellant which it considers a major breakthrough. Called Flexadyne, the perchlorate aluminized propellant is said to offer 100% improvement in elongation and tear resistance.

### Countermeasure Competition

Some of the hottest company competitions now under way concern Air Force proposals for missile countermeasures. One of the bigger ones is understood to involve a $100 million contract. Several electronic companies have lines up into teams to get in on the bidding.

### R&D Intelligence

Latest *Nike-Zeus* shot aborted after the first-stage head burned through. Score now: 8 successes, 3 partials, 3 failures. . . . *Nerva* is the new name for flight version of nuclear rockets developed under NASA-AEC Project *Rover*; non-flight models will still be called *Kiwi* . . . Chrysler is the fourth company in the *Saturn* booster tank competition (see p. 31) . . . AF is holding conferences on problem of monitoring critical hotspots on *Dyna-Soar*. Astronauts may use a fibre optics system. . . . An aircraft-controlled undersea vehicle capable of spotting enemy submarines and mines is now under advanced development.

### Commercial Satellite

Cook Electric is getting ready to market a commercial launch vehicle capable of placing a 100-lb. payload into a 200-mile orbit. Components are said to be off-the-shelf.

### Nova: $10 Billion

Latest estimate for developing the multi-meg thrust *Nova* booster is now put at $10 billion. Any decision to get the project going would entail a major commitment of available space funds. Hence, none is expected without a searching reappraisal by the Kennedy Administration.

## INTERNATIONAL

### New Space Combine

In a perhaps premature move, eight major British industrial concerns have set up a brand-new British Space Development Co. to exploit the commercial uses of space. The company was formed in anticipation of the European Space Club becoming reality. Hopes for this international joint venture now seem doomed with the withdrawal of support by West Germany. Still, the new British combine is significant in that it is the first broad attack by private capital to venture into space. Participants include: Associated Electrical Industries, Associated Television, British Insulated Callenders Cables, Decca Radar, de Havilland, Pye, Rank Organization and Rolls-Royce.

### Overseas Pipeline

India is said to be in the market for *Sidewinders* and British *Bloodhound* missiles. . . . Norwegian Army personnel have fired *Honest John* missiles successfully in field trials. . . . An official West German military journal, "Bundeswehr," says Russia now has 10 permanent ICBM bases equipped with 5000-mile birds on launchers.

*Second source possible . . .*

# Hike in Minuteman Output?

***Production rate could be raised 50-100% to speed deployment—may create industry problems. First silo shot is still set for summer as Air Force moves ahead with instrumentation. Elaborate electrical grounding needed to prevent radio interference of remotely operated launch equipment poses unique problem***

**by Hal Gettings**

CAPE CANAVERAL—The Defense Department is considering ordering a 50-100% increase in the *Minuteman* production rate to speed ICBM deployment.

Approval of the proposal could affect the present contracting setup headed by Boeing Airplane Co. There is one report that the Air Force may create a duplicate contractor team to second-source the entire *Minuteman* system.

Any decision to increase *Minuteman* production greatly would have to be made within a few months—to take maximum advantage of the time which could be saved in placing the big solid-fueled missiles in silo launchers. Bids are now being studied for contracts to build the first 150-launcher *Minuteman* complex at Malmstrom AFB, Mont. Construction had been scheduled to start late last year.

While a step-up in *Minuteman* production is one of the major items in the current DOD review of U.S. strategic forces, no speed-up is presently planned in the first full-scale silo shot from Cape Canaveral—despite the success of its first flight test (M/R, Feb. 6, p. 14.)

Silo launch facilities are on schedule and Ballistic Missile Division officers are confident that ground equipment will be installed well ahead of the first silo shot, scheduled for this summer.

Construction of one silo, complex 32, already is finished and instrumentation probably will start next month. The other silo is not far behind.

BMD made it clear, however, that project efforts will be devoted to seeing that the silo shot gets off on schedule rather than accelerating the schedule.

• **Handsome payoff**—In Los Angeles, Col. Sam Phillips, BMD *Minuteman* program director, told MISSILES AND ROCKETS that all phases of tracking and instrumentation worked perfectly during the 4200-mile Feb. 1 research and development flight.



*SUCCESSFUL Feb. 1 launching.*

"Everything worked exactly as it had been designed to work," Col. Phillips said, adding that early study of telemetry results indicates "we're not due for any surprises."

"If there is any single thing that stands out above others in the test results," Phillips said, "it is our feeling that all our efforts in stressing reliability have paid off handsomely."

Engineers at Autonetics echoed this in their post-flight analysis of the guidance and control system. "This is not the end, just the beginning," one said.

The *Minuteman* shot was reported to have impacted well within the target area. Autonetics said the missile pitch action after liftoff, which caused some comment, was due to the guidance system, which puts the missile on trajectory "right now."

• **Minimum complexity**—Simplicity of the solid-fueled, 6300-mile *Minuteman* is reflected in the lack of clutter and elaborate equipment on the pad and in the operational-type silos.

Gantry and umbilical towers are simple and clean. The pad consists of a launching ring set over an uncomplicated blast deflector. Elimination of the complex liquid-fuel handling equipment is, of course, the key to the simplicity of the ground support equipment.

The silos are, at the surface, simply holes in the ground surrounded by concrete aprons. Electronic gear for both pads and silos is located in an underground room.

The R&D silos—essentially the same as those to be used in operational hardened sites, with the exception of the cover—are based on designs proved out in development tests at Edwards AFB, Calif.

Firing tubes, 12 ft. in diameter and made of reinforced concrete lined with steel, are surrounded by underground galleries within an outer concrete silo. Instrumentation, power and auxiliary equipment will be located in the galleries.

The R&D ground electronic equipment here at the Cape closely approximates the operational gear. After use in the first few launches, this will be replaced with an operational system.

There are no exhaust ports in the silo. A small concial spreader at the bottom of the tube will deflect the blast up and around the missile as it rises out of the tube. No skid bars or other mechanical devices are necessary to guide the 60-foot missile out of the hole; its own guidance system keeps it vertically centered as it emerges on launch.

A chute, aiming North and slanting down to the collimator bay near the

top of the tube, is used to provide optical sighting of the North Star *Polaris* to calibrate the missile's guidance system.

• **Underground electronics** — One unique feature of the silo construction is the elaborate electrical grounding network buried around the site. Radio interference problems with the sensitive instrumentation made this additional protection necessary.

The R&D ground electronic equipment, designed to be remotely operated during launch, is checked out, sealed and not reopened until after the launch —or until trouble develops. In operational deployment, the three-stage *Minuteman* will be lowered into the underground bomb-proof silo, checked out, tied into its communications and monitoring equipment, and then the lid will be closed. From then on, the missile is ready to go at a moment's notice.

• **New depth for Florida**—The silos, built by the Army Corps of Engineers, represent several new and unusual construction techniques. The 90-ft.-deep structures—the deepest dry holes in Florida—were built practically under water, with attendant problems not encountered in conventional construction. In addition, the silo has to withstand the tremendous blast pressure of the missile launch—up to 3000 psi.

Each hole is 109 feet deep overall with a 12-ft.-thick seal of tremie concrete at the bottom covered by a 7-ft. layer of reinforced concrete. The sides of each silo were designed to a thickness of three feet with an inner diameter of 26 feet. This thickness was changed to four feet for the added weight necessary to keep the structure from floating. Each silo weighs about 4000 tons and contains more than 100 tons of steel reinforcing.

Work on the silos was started in July, 1959, by the Dravo Corp. The caisson sections were precast above ground. The first caisson—roughly 14 feet high—was placed on top of a triangular cutting shoe made of half-inch steel plate. This section was sunk into the sandy soil by its own weight.

On top of each caisson, construction joints were formed to provide horizontal shear keys with the vertical rods in the reinforcing steel mats serving as dowels. In addition, a 12-in. rubber water stop was cast in the concrete at each caisson joint.

After the first caisson was sunk, precast topping caissons 20 feet high were lifted into place. A curing compound made of a crude liquid floor wax was applied to the outside surface of each caisson to retain moisture in the concrete and lubricate the outside surface to reduce skin friction during the sinking operation.



*MINUTEMEN WILL BE LOWERED into silos by same transporter-erector used in handling surface-launch missiles. Missile shown here is a test model.*

• **Even sinking**—As the caissons sank under their own weight, the waterlogged soil inside the silos was removed around the cutting shoe to allow even sinking. The water level inside the caissons was kept at the same level as the ground water level outside to equalize the hydraulic head.

When the caissons were sunk to about 80% of the completed depth, friction overcame their weight and the sinking stopped. To continue the sinking, well points—spaced 18 inches apart around the caisson circumference —were sunk to the edge of the cutting shoe. Compressed air, controlled by valves to each group of points, was fed into the lines in spurts at 150 psi. These air jets eased the pressure on the cutting edges, reduced the friction, and aided the sinking process.

After the final caisson was sunk, the tremie concrete seal or plug, 14 feet thick, was poured. Since the silos were full of water, a water-tight steel pipe was fabricated to extend from a platform suspended a few feet above the top of the silos to the bottom. The tremie concrete was fed into a hopper on top of the platform.

After the pour was completed, the plugs were allowed to cure out for two weeks before the silos were pumped dry. When the pumping was completed, the top surface of tremie seal was cleaned and scarified to receive the structural concrete floor cover seven feet thick. This floor was poured dry.

Specifications required that the center line of each silo be kept within a circle with a radius of one foot. The one farthest off the mark was found to be off by only 2⅜ inches. ⌗

## West Coast Silo Started

*Construction of the first Minuteman silo and launch facilities has begun at Vandenberg AFB, Calif., under a $2.5-million contract awarded Stolte Construction Co., Los Angeles.*

*Launch facilities will include rail spurs for mobile Minuteman emplacements.*

*The silos themselves are expected to be completed by late September; installation of ground support and operational equipment will follow. The complete facility will include two missile control centers, one above ground and one below, and one destruct package building. The latter will house materials used in test and training launches for range safety in event of missile malfunction.*

# Latest Reports Say Missile Gap Continues

***Apparent conflict in varying stories may be caused by confusion of 'missile' and 'destruction' gaps***

**by James Baar**

NEW U.S. INTELLIGENCE estimates—no more than a week old—are understood to report no change in the existence of a Missile Gap. Russia continues to hold about a 3-to-1 edge in ICBM's over the United States.

The estimates, made without benefit of U-2 overflights, are understood to be precisely the same as intelligence reports of a year or more. They show that if the current scheduled rate of deployment of U.S. missiles remains unchanged, a gap of at least 3-to-1 will continue through the early 1960's.

The life-or-death question is whether during this period the United States has enough bombers and other strategic weapons to prevent a "deterrent gap" or "destruction gap" from opening up as well.

These are the key factors that must be kept in mind in any evaluation of last week's contradictory reports on the Missile Gap.

• **Background**—These also are the factors that clearly were behind previous statements made by the two principal figures in the latest Missile Gap debate—President Kennedy and Defense Secretary McNamara.

Kennedy told Congress bluntly in his State of the Union Message:

"Each day we draw nearer the hour of maximum danger as weapons spread and hostile forces grow stronger . . . I have directed prompt action to accelerate our entire missile program."

Then he announced that he had directed McNamara to conduct the current complete review of the nation's defense strategy and forces, in order to decide what additional effort would be needed.

Only three days later McNamara told a news conference that he did not wish to comment on the Missile Gap because the studies which had begun about Jan. 20 had not been completed. However, later this exchange took place:

Q—"Mr. Secretary, General Eisenhower in his last State of the Union Message said that the Soviet bomber threat was fiction and the ICBM threat might prove to be the same. Is that one of the studies that you might be making . . .?"

McNamara—"I believe that the question was that President Eisenhower stated that the Soviet bomber threat and the Soviet missile threat was fiction. I wasn't aware that he said that. I don't believe it is . . ."

Q—"The President said that the gap, between the United States and Russia, insofar as bombers, had proven to be fiction."

McNamara—"As I mentioned earlier, I don't wish to comment on any gap. I am simply stating that I don't think it is fiction."

Four days later top Defense officials were reported with varying degrees of hardness to have concluded from their studies to date that no "destruction gap" exists today and that the number of ICBM's on either side is insignificant in the total military equation.

Some reports said the Missile Gap had been found not to have materialized so far and that it would not materialize. There were other variations.

• **Inevitable question**—The next day, Feb. 7, Presidential News Secretary Pierre Salinger said the reports that no Missile Gap had been found were inaccurate. And the following morning the President faced the inevitable question at a news conference.

Q—"Mr. President, in the past 24 hours there has arisen a somewhat hard to understand situation concerning the missile gap. An official of your Administration, who was identified in some newspapers this morning as Secretary McNamara, has been quoted as saying that the missile gap which was expected and talked about so much did not exist, nor did he see prospects of it.

"Your Press Secretary, yesterday afternoon, denied this story. Now, I wonder if you can set the record clear, if you can tell us your version of what Secretary McNamara said, and what your feelings are about the missile gap. Does it exist, and how and where does it exist?"

THE PRESIDENT: "My only conversation with Mr. McNamara was not at any off-the-record meeting, if such a meeting took place, but was in a conversation which I had with him yesterday afternoon after the reports appeared.

"Mr. McNamara stated that no study had been concluded in the Defense Department which would lead to any conclusion at this time as to whether there is a missile gap or not. In addition, I talked this morning to Mr. Hitch, who is the Controller of the Defense Department, who has been given the responsibility by the Secretary of Defense to conduct a review of your strategic weapons, in the same way that Mr. Nitze is conducting a review of our tactical weapons. Mr. Hitch informed me that no study has been completed on this matter.

"He hoped to have a preliminary study completed by February 20th, but he did tell me quite specifically that as of today he is not prepared to make a judgement as to our capacity in strategic weapons.

"There are complicated problems involved. We have the realization that the United States will not strike first, and, therefore, we have to consider what will be available to the United States if an attack took place upon us, not only in missiles, but in the other arms of our arsenal, SAC, the Navy, *Polaris*, and all the rest.

"So I think in answer to your question, the study has not been completed, and it has not come, therefore, across my desk. There will be a study of how the budget for fiscal 1961 and 1962 should be changed in view of our strategic position, but that study will not be completed by either Mr. Nitze or Mr. Hitch, or come across Mr. McNamara's desk to be passed to me for some days."

• **Much ado on Hill**—Meantime, Congress reacted loudly.

House Republicans demanded that Kennedy apologize to Eisenhower for what they called "slander" by Democrats who had charged there was a Missile Gap. Rep. Thomas M. Pelly (R-Wash.) sarcastically praised the Kennedy Administration for ending the Missile Gap in "just 18 days."

Sen. Prescott Bush (R-Conn.), a member of the Senate Armed Services Committee, called for an investigation. Later, Chairman Richard Russell of the Armed Services Committee said he would call for beginning the committee's annual "military posture" hearings Feb. 20.

Thus, the committee will meet just in time to hear the results of the Administration studies. At that time, the Administration will have to disclose how it plans to meet the Missile Gap that continues to be reported by U.S. intelligence sources. ⌘

## *Re-entry trouble?*

# Soviets Set New Weightlift Record

THE RUSSIANS were one-up in space again this week with the launching of 7.1-ton *Sputnik VII*, heaviest object yet placed in orbit. The Feb. 4 launch came just four days after the U.S. sent a chimpanzee soaring 420 miles down the Atlantic Missile Range aboard Mercury Redstone 2.

With America's first manned ballistic space flight perhaps less than 60 days off, the Russians said their new satellite was a "step forward" in their manned space flight program.

The Soviet Union gave out few details on *Sputnik VII* and did not state whether an animal or man was aboard. The official announcement by Tass news agency gave the perigee as 138.5 miles, apogee as 203.5 miles. Orbital inclination was 64° 57′ and period 89.9.′

President Kennedy said at his news conference last week: "We have no evidence that there was a man in the rocket." The White House disclosed that the President had been informed of the Soviet launching by U.S. "Intelligence sources" prior to the Moscow announcement. These presumably were electronic tracking stations.

But use of the unusual phrase "intelligence sources" raised some speculation that *Samos II*, the new U.S. spy satellite, might have played a role in the detection of the launching. A research and development model of *Samos* was launched into polar orbit with high-resolution camera equipment on Jan. 31. The Air Force refused to comment on this possibility.

• **Propulsion prowess**—Weight of *Sputnik VII* was taken as an indication of improved Soviet launch capability. Tass referred to an "improved multistage rocket" as the launch vehicle.

A Czechoslovakian technical publication reported that a new heat-resistant alloy of high strength and low specific gravity is now employed in rocket engines in the USSR. It said these engines develop thrusts of 1-million kg. (2.2 million lbs.)

If the report is accurate, the Soviet Union is even further ahead of the U.S. in this field than previously suspected.

Some U.S. propulsion experts expressed doubt that a new rocket was needed. They pointed out that a payload increase also can be attained with a lower orbit or by use of better guidance.

### *Russian Satellite Launchings*

| Name | Launch Date | Perigee-Apogee | Status |
|---|---|---|---|
| **Sputnik I** | Oct. 4, 1957 | 142-588 miles | Down Jan. 4, 1958 (92 days) |
| **Sputnik II** | Nov. 3, 1957 | 140-1038 | Down Apr. 4, 1958 (162 days) |
| **Sputnik III** | May 25, 1958 | 105-328 | Down Apr. 6, 1960 (692 days) |
| **Lunik I** | Jan. 2, 1959 | Around sun on 15-mo. period | In orbit, est. life millions of years |
| **Lunik II** | Sept. 12, 1959 | Traveled 236,875 mi. | Impacted on moon Sept. 13 |
| **Lunik III** | Oct. 4, 1959 | 24,840-292,000 | Down Apr. 20, 1960 (199 days) |
| **Sputnik IV** | May 15, 1960 | 174.7-359.8 | In orbit |
| **Sputnik V** | Aug. 19, 1960 | 189-210 | Down Aug. 20, 1960 |
| **Sputnik VI** | Dec. 1, 1960 | 106-146 | Down Dec. 2, 1960 |
| **Sputnik VII** | Feb. 4, 1961 | 138.5-203.5 | Expected short life |

Possibility of an up-rated upper stage or an additional stage was not ruled out. But experts here doubted the Russians would develop an entirely new booster to obtain only a 40% increase in payload. The jump would be even bigger than that, they guessed.

• **Tracking reports**—The North American Air Defense Command NORAD was among the first to confirm the *Sputnik VII* orbits. NORAD's monitoring stations traced the object through six orbits while it was transmitting signals. NORAD recently took over direction of the Navy's space surveillance system.

From New York, the Radio Corporation of America reported on Feb. 5 no success in picking up any radio trace of the satellite. The same report came from the Astro Observation Station of the Army Signal Research and Development Laboratory at Fort Monmouth, N.J.

The Air Force National Space Surveillance Control Center at Bedford, Mass., disclosed it was tracking the Soviet satellite but declined to release any information on the grounds that it had no assigned mission regarding the *Sputnik*.

National Aeronautics and Space Administration's Goddard Space Flight Center reported it had not been able to detect any radio signals from the Russian satellite and was unable to track it.

Silence from the satellite after launch was regarded by a number of U.S. space officials as indication of a power failure. It was believed that the primary purpose of the satellite was data gathering. This was supported by the fact that most Soviet comment on it came from Russian cosmic ray, ionospheric and micrometeorite experts.

• **Russian comment**—Prof. Ivan Shevlyakov of Moscow Planetarium called the shot "a leap in the creation of rockets for space travel." Tass referred to the satellite as a *Sputnik*, not a space ship. The latter designation apparently is a propaganda term for satellites which have carried animals.

Tass, for example, referred to the new shot as *Sputnik V*. But a wire from Moscow to the Scottish Royal Observatory later in the week properly referred to it as *Sputnik VII*.

Shevlyakov said the low perigee of the satellite would result in its burning up in the atmosphere within a few days after launch. Some Western experts raised the question of whether the Russians were continuing to have difficulty with re-entry problems, already solved by the U.S.

Tass gave the weight of the satellite as 6483 kilograms or 14,292 lbs.

In terms of the U.S. short ton of 2,000 lbs., the object weighed 7.1 tons. By Soviet metric standards, it weighed 6.48 metric tons.

Announced weight did not include the last stage of the multi-stage launching rocket, according to Tass.

Speculation that the Russians might have placed a man aboard the satellite arose when observatory scientists at Bochum, Germany, reported picking up what might have been Russian Words in Morse code from space.

The report followed claims by two "ham" radio operators in Turin, Italy, that they had picked up what sounded like "moaning or heavy breathing" from space. The reports from both Germany and Italy were made before Moscow announced the launch. ⌘

*At Senate urging . . .*

# Overhaul Coming in Procurement Rules

***But Pentagon will go slow in making any changes in contract cost principles; nine steps planned***

THE PENTAGON has told Congress that it will revise its procurement rules in line with a Senate Armed Services Committee recommendation.

But Capt. J. M. Malloy, chairman of the Armed Services Procurement Regulation Committee, says that any changes in contract cost principles—Section XV of the ASPR—will be ground exceedingly small before they are incorporated.

The proposed change, permitting a contract officer to reduce target cost where price was based on inaccurate or out-of-date cost data, is one of nine steps the Pentagon says it is taking to improve procurement techniques as recommended last year by the committee.

The proposal calls for an adjustment provision in all negotiated fixed price contracts over $100,000, unless the contract price is based mainly on price competition or established catalogue prices. It would permit the contracting officer to "equitably reduce the contract price if he determines that the cost was overstated because any contractor or first-tier subcontractor failed to disclose any significant and reasonably available cost data or furnished any data he knew or reasonably should have known was false and misleading."

DOD said it will also revise the Armed Services Procurement Regulations to require solicitation from the maximum number of offerers "consistent with the nature of and requirements for the supplies and services to be procured, in accordance with the basic policies set forth in Section 1, part 3, to the end that the procurement will be made to the best advantage of the government, price and other factors considered."

In line with the committee's recommendation for "more specific determinations and findings," DOD said it will change the rules to read: "Each determination and finding prepared in accordance with departmental procedures shall set out enough facts and circumstances to justify clearly the specific determination made. Each determination and finding for authority to negotiate either an individual contract or a class of contracts shall clearly indicate that the use of formal advertising would be impracticable and the reasons therefore."

DOD said it had also taken steps to develop adequate contract specifications and that it is continuing to encourage prime contractors to use the Department of Commerce synopsis to publicize opportunities in the field of subcontracting stemming from their defense business.

Capt. Malloy spoke to a group of about 500 industry representatives at the recent National Security Industrial Association Seminar on DOD procurement.

Malloy pointed out that current cost principles—revised just a little over a year ago after several years of study—deal with broad policy and that there is no "neat package" solution to all costing problems. "Everyone," he said, "wants these neat packages when it suits his own particular approach, but I am rather certain . . . of the fallacy of this approach."

Malloy took a dig at industry for objecting to the degree of specificity and detail incorporated during the development of the cost principles. Now, he says, industry representatives are complaining that the regulation is not specific enough. On one hand, he said, industry argues for general policy guidelines and, on the other, it seeks specificity as a protection against contracting officer interpretations.

• **Where changes may come**—Malloy noted these items under study aimed at possible changes or additions to ASPR cost principles:

–Cost principles applicable to acquisition of facilities and to construction contracts. These, which will appear in parts 4 and 5, are now in draft

## Renegotiation Bill

*Legislation has been introduced to give the General Accounting Office authority to review negotiated government contracts.*

*Sen. John Sparkman (D-Ala.), chairman of the Senate Small Business Committee, said that present procurement regulations permit the use of negotiation when "procurement could be formally advertised." The new authority would be identical to authority GAO presently has to examine advertised procurements and could amount to advance screening of all negotiated defense contracts.*

*Sparkman said that "When contracts are advertised openly instead of negotiated, small firms have a much better opportunity to sell their goods and services to the government." The new legislation, he claimed, would authorize GAO to question only those decisions to negotiate that are "clearly erroneous, arbitrary or capricious, or not supported by substantial evidence."*

form and available for review and comment by industry associations.

–Cost principles applicable to research contracts with educational institutions (part 3). Being revised to reflect changes directed by Bureau of Budget.

–Cost interpretations. Establishment of new part 7 to contain so-called cost interpretations is being seriously considered by the committee, but problems are many. Such an addition might include additional guidelines as to reasonableness or allocability in connection with a particular cost item.

–Location allowances. Revision 3, published on Jan. 31, will be aimed at eliminating abuses of location allowances or incentive pay and define more strictly criteria for recognition.

–Recruiting expenses. High costs of recruiting to continue to get hard look although no changes are contemplated at present.

–Advertising. Basic study being undertaken to amplify and clarify general terms of present cost principles. No predication as to outcome.

–Development expense. Study underway to determine whether independent development expense can be allocated to all work of a contractor in the contract product line (including R&D) or only to production contracts.

–Personal property taxes. Tentative view is that state taxes on defense material, when significant, should be handled as direct cost. Method of implementing is under study and could result in change in cost principles and to standard tax clauses as well.

–Interplant material transfer. In spite of some industry agitation for liberalization of cost principle concerned with charges for material transferred between plants or divisions under common control, no basic changes are contemplated. Present ASPR coverage represents liberalization over previous treatment and is a compromise between industry and government positions.

–Bidding expense. DOD takes dim view of R&D effort expended and charged off for elaborate unsolicited proposals. Additional restrictions are threatened if "needless costs" in this area are not cut down.

In addition to Malloy, an imposing list of speakers and panel members—top-level military and industry procurement and contracts specialists—appeared in the two-day seminar. The subject of DOD procurement regulations and their administration was thoroughly covered in what was perhaps the most comprehensive treatment ever given the subject in open meeting. ⌗

# AF Savings
## Contractors Report Cuts of Half-billion

Evidence of cost savings of more than a half-billion dollars by Air Force contractors is being presented to Congress during FY 1962 budget hearings.

In an effort to dissuade Congress from another across-the-board slash in defense procurement appropriations, the 28 Air Force contractors will show how they cut $570.9 million in costs by streamlining methods.

The companies listed savings in these categories: general cost-reduction programs, $373.9 million; better purchasing procedures, $36.8 million; value engineering, $28.6 million; reorganization and consolidation, $5.9 million; facilities modernization, $1.7 million; labor savings, $10.3 million; overhead costs reduced, $29.7 million; better plant methods, $13.7 million; reduction of inventories, $3.3 million; use of electronic data processing, $1.3 million; cooperation among industries, $65.7 million.

The listing came in answer to a letter by Lt. Gen. Mark E. Bradley, AF deputy chief of staff (materiel) to principal contractors. The dollar total doesn't include savings effected by subcontractors, reductions related to improved management methods—or other intangibles not readily measured.

Air Force materiel chiefs feel they have a good case to present to Congress to forestall budget reductions in procurement. Similar programs in the Navy and Army will attempt to avoid arbitrary procurement cuts as disciplinary measures against careless spending. ⌗

# Uhl Chosen to Head Fairchild Corporation

Edward G. Uhl, recently vice president and San Diego Division manager of Ryan Aeronautical Co., has been elected president of Fairchild Engine & Airplane Corp., Hagerstown, Md.

He will replace Sherman Fairchild, board chairman, as executive officer effective Feb. 20. Fairchild became acting executive officer last Oct. 5 following the resignation of J. H. Carmichael. Since then he has directed a reorganization of the company, including the appointment of J. T. Dresher as vice president-finance and John L. Grapper as secretary.

Uhl began his business career at The Martin Co. in 1946, and was successively a research engineer, project engineer, section head, chief project engineer, VP-chief engineer and VP-general manager, the last being at the Orlando, Fla., division of Martin. As VP-general manager at Orlando, he administered an organization that grew in 28 months to 6700 employees and had a backlog of $175 million in five major missile/space projects.

He joined Ryan in July, 1959, as VP-technical administration, San Diego.

# Zeus Production Gets New Backing

*Congress is giving strong new support to the Army's bid to begin production of the Nike-Zeus anti-missile missile.*

*At the same time, the Kennedy Administration is actively considering a proposal to start producing the big missile system on an interim basis.*

*The so-called interim plan recommended late last year by a special Ad Hoc Committee (M/R, Jan. 30) would obligate about $270 million over the next 17 months, if production was ordered immediately.*

*Rep. George Mahon (D-Tex.), chairman of the House Defense Appropriations Subcommittee, indicated that he would favor an Administration request to begin the "interim plan."*

*On the floor of both the Senate and the House, Zeus received far more outspoken support.*

*Sen. Strom Thurmond (D-S.C.), a member of the Senate Armed Services Committee, said "we must start production of the Nike-Zeus now," and called for giving the Army the necessary money and authority.*

*"Further delay increases our risk. We can no longer run the risk of being half safe. I am convinced from the development tests of the components to date that the Nike-Zeus can provide the defense this nation needs to meet and master the intercontinental ballistic missile threat."*

*Rep. George P. Miller (D-Calif.), a member of the House Space Committee, told the House that "The United States will struggle in a straitjacket if it does not parallel its retaliatory ICBM with an antimissile missile defensive weapon system against the ballistic blackmail of the Soviet Union."*

*Miller said "the answer is Nike-Zeus—both as a missile killer and a satellite killer."*

*"The starting of production of the Nike-Zeus immediately will buy the precious time that we need," he said.*

# G.E. Wins Delayed Contest For Primer Nimbus Contract

GENERAL ELECTRIC'S Missile and Space Vehicle Division will head a team of contractors that will develop the *Nimbus* advanced weather satellite for flight by late 1962.

Selection of GE for prime and control and stabilization subsystems contracts totaling $4½ million ended a procurement delay that will cause about six months' slippage in the first launching, previously scheduled for the second quarter of 1962.

The National Aeronautics and Space Administration on Feb. 3, also announced these subsystem contractors, chosen earlier but kept secret: RCA Astro-Electronics, cameras and solar power systems; IT&T Laboratories, infrared equipment; Santa Barbara Research Center, infrared equipment; Radiation Inc., telemetry system; California Computer, command system.

The initial contract calls for flight of two satellites, lifted by *Thor-Agena B* boosters into 600-mile circular 80°-inclined orbits down the Pacific Missile Range. However, later versions of *Nimbus* are to be the eventual operational weather satellite of which many launchings are planned.

*Nimbus* weighs about 650 lbs., compared with about 280 lbs. for the *Tiros* series. Other differences:

–Its television cameras point permanently toward the earth. *Tiros* is spin-stabilized.

–Its near polar orbit will allow coverage of the entire globe. *Tiros* covered only areas between the 50° circles of latitude.

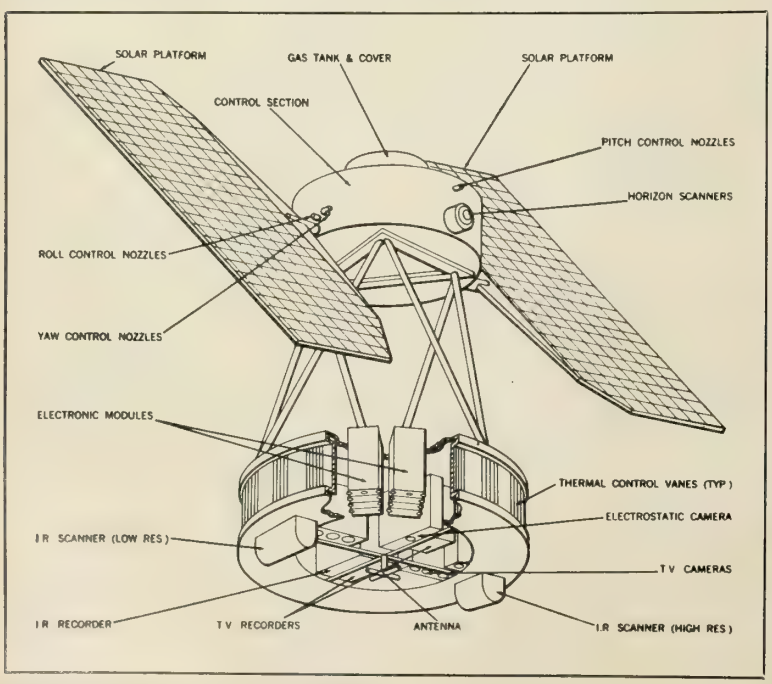
–It has six television cameras, compared with two for *Tiros*.

NASA's Goddard Space Flight Center is negotiating details of the prime contract and will manage it. GE was chosen from six bidders. The others were Temco, RCA, Grumman, Bendix and Republic Aviation.

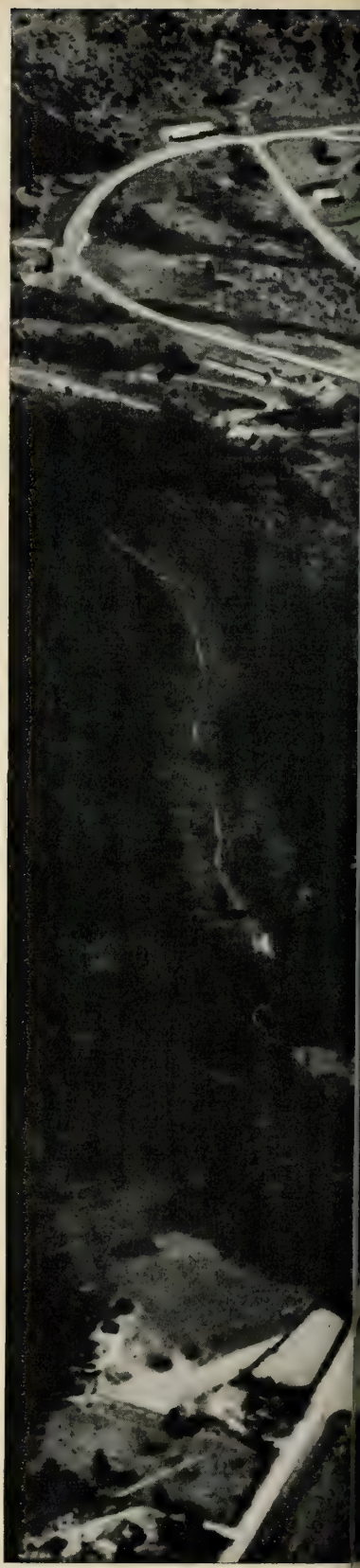
Solar cells on two large paddles and storage batteries will provide power.

Gas jets and inertia wheels for fine control will rotate the spacecraft every 108 minutes—its orbital period—to keep it pointed toward the earth. Thus the effective life will be limited by the amount of gas available for the stabilization jets.

Cloud-cover pictures and other data will be played back by command from a primary data-acquisition site at Fairbanks, Alaska. The U.S. Weather Bureau and the Department of Defense will analyze all data and make meteorological information available to foreign scientists. ⌗




*NASA SCHEMATIC of Nimbus satellite*






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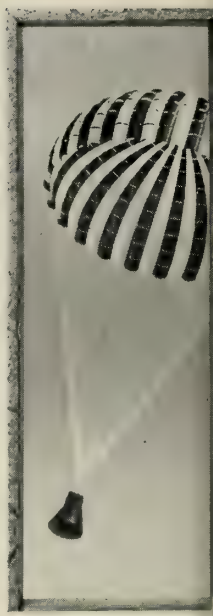
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**POLARIS:** Northrop's Datico checks out Polaris at all levels of maintenance and operation.

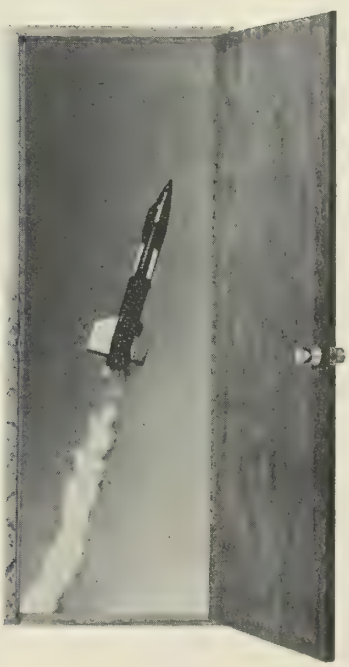


**SKYBOLT:** Guidance and navigation systems are being developed by Northrop for this new and highly secret air-launched ballistic missile.



**MERCURY:** The Northrop landing tem is designed to bring the cury astronaut down safely.

# Northrop is now active in mor



**X-15:** Northrop produces Q-Ball, the flight angle sensor for safe re-entry of X-15 and other aerospace vehicles.



**AERODYNAMICS:** Northrop's Laminar Flow Control technique is designed to greatly increase aircraft range, flexibility, cargo and passenger capacity.

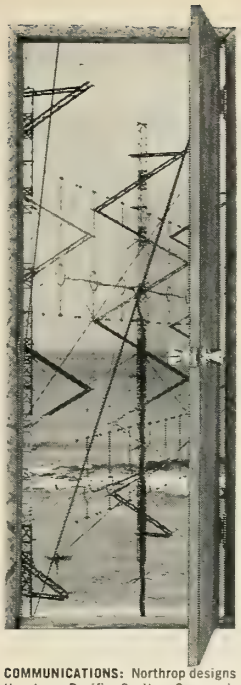


**TITAN:** Northrop supplies con technical and industrial manag to activate the T-2 Titan missile

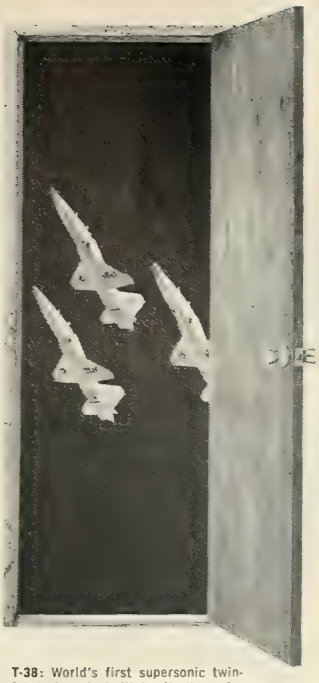
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**VK:** Northrop produces airframe ponents, ground handling and ching equipment for this air de- e missile.

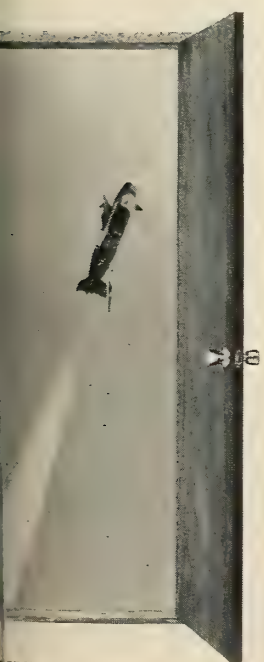


**COMMUNICATIONS:** Northrop designs the trans-Pacific Scatter Communications Network and other worldwide communication systems for U.S. and free world governments.



**T-38:** World's first supersonic twin-jet trainer is built by Northrop for the United States Air Force.

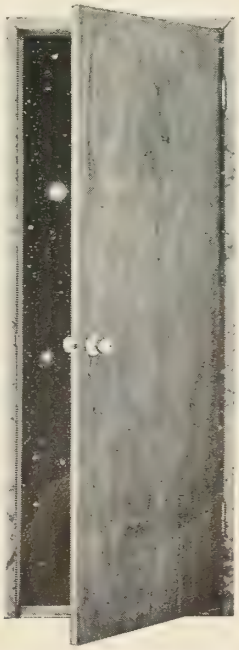
# han 70 important programs



**ET MISSILES:** Northrop has pro- more than 50,000 electroni- controlled aerial targets, and illance drones.



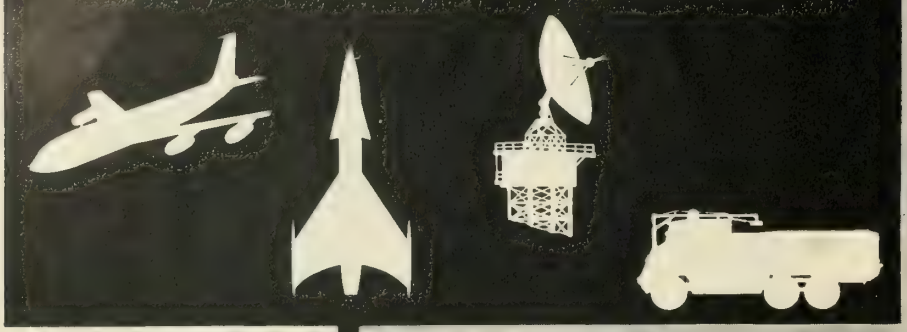
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# Technical Countdown

## ELECTRONICS

### Peltier Cooling Advanced

Hughes Aircraft has developed a new material fabricating technique permitting thermoelectric coolers to operate at one-tenth the power normally required. Its heating efficiency is up to eight times as high as that of conventional resistance heaters, Hughes says. A three-unit, cascaded Peltier cooler has been used experimentally for infrared detector cooling to −100°F and drawing but 2 amperes of current.

### Transistor Power to be Lowered

Taking another approach to electronics cooling, CBS Laboratories has embarked on a program for the Army Signal Corps to reduce existing circuit heat problems by vastly decreasing transistor power requirements. Specifically, the Lab will try to develop a silicon switching transistor for computer use that will require "several hundred times less power than conventional transistors."

### Improved Memory Produced

A low-cost, light-controlled computer memory device has been developed for the Navy by scientists at New York University. Exploiting the phenomenon of persistent internal polarization, data can be impressed on a polarized solid-state plate by a small voltage and a beam of light, stored, and released again by a light beam. The plate employs a thin phosphor photoconductive layer. Both storing and access time are in "fractions of a microsecond," according to the Navy; and data density is much higher than with conventional memory devices.

### New Fuzing and Arming Approach?

Tempo Instrument Inc. reportedly has developed the first solid-state arming and fuzing device. No details are available yet, except that the unit is believed to be entirely non-mechanical, employing no moving parts. Such a device could offer a real step forward in reliability—and this in a field that almost invented the word.

## SUPPORT EQUIPMENT

### NAP-100 Now Under Test

A new, 40-lb., thermonuclear electric-power generator, built by Westinghouse, is undergoing test operation at the Air Force's ARDC Special Weapons Center in Albuquerque, N.M. The hat-box-size portable unit is designed to produce 150 watts continuously for up to 1 year of unattended service, the Air Force says. Called the NAP-100, the system uses radioactive isotopes (such as Curium 242) to provide a heat source of about 1000°F for 144 semiconductive elements. Extremities of elements are maintained at 300°F to obtain Peltier-effect direct energy conversion.

### ABLE Ready for Field Use

Autonetics' ABLE, a portable north-determining artillery or missile orienter, has successfully passed its exams at Fort Huachuca and has been ordered into production. The unit is basically a gyrocompass capable of determining true north to under 30 seconds of arc standard deviation in just a few minutes time. The Army says ABLE requires no star reference, bench marks or other fixed aids.

### Inflated Engine Handler Devised

Presray Corp., Pawling, N.Y., reports it has developed a pneumatic handling device for inserting and removing engines in the first stage of *Saturn*. The device, called Pneuma-Grip, is inserted inside the nozzle and throat area inflated, so that the only material touching the sensitive inner surface is air-pressure supported rubber.

## ADVANCED MATERIALS

### High-Temp Steel Seals Developed

Self-compensating alloy-steel seals have been developed by B. F. Goodrich Aviation Products for hydraulic systems operating in temperatures up to 530°F and under pressures up to 6000 psi. The concept is that of a blunt knife-edge with controllable unit load that can seal pressures while holding the load on the radial edge of the seal as low as possible, keeping the break-out force low.

### B-70 Honeycomb-Density Reduced

Substantial weight savings throughout North American Aviations' B-70 bomber have been achieved with chemical milling techniques developed by U.S. Chemical Milling Corp. The process cuts down the density of the stainless-steel honeycomb core used extensively in the Mach 3 aircraft.

### Prepregnated-Plastics Record Expected

President Kennedy's announced push in missile and aircraft production should increase sales of prepreg materials over the 1960 figure of $25 million. Prepregs are ready-to-mold combinations of resins and reinforcement; the missile industry is largely responsible for the spectacular increase in sales, which added up to a mere $1 million in 1956.

## ASTRONAUTICS

### Rebound to Last 10 Years

The rigidized 140-ft. balloon satellite being developed under NASA's Project *Rebound* is expected to have a useful life of about 10 years, compared with six months to a year for the *Echo* passive communications balloon. About a half-dozen will be launched in each of a series of firings with *Centaur* vehicles, the first in about two years.

### Lunar Landing Scheme Revealed

Latest wrinkle in plans for a manned lunar landing is that a duplicate spacecraft would land a month previously, check itself out completely and radio back that it is in operable condition. NASA propulsion specialists figure that if the manned vehicle is damaged on landing, the astronaut can get out and walk to the other vehicle for the return to earth.

### Atlas Control System De-Bugged

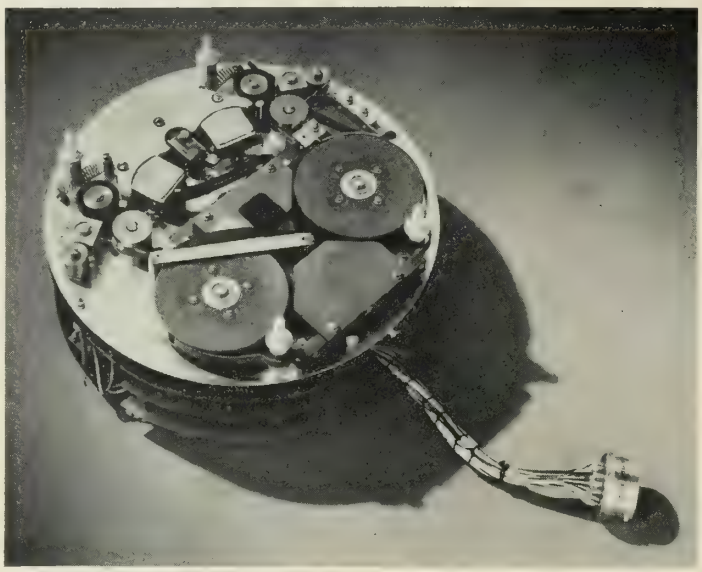
Problems plaguing the first three *Atlas-E* launchings are believed solved. The trouble was finally nailed down to the hydraulic control system. Earlier system improvements introduced new problems, but Convair now is looking confidently for a successful launch with No. 4 sometime this month.

# New Breed of Recorders for Futur

***Raymond Engineering Lab's tiny tape units, slated for trips in S-16, Tiros and other satellites, could set standards for tomorrow***

A FAMILY of new miniature FM tape recorders, embodying advanced mechanical design, may have set the criteria for future development of such instruments for space use.

Developed for a whole series of NASA's upcoming satellite programs, the units appear to have all the necessary ingredients for obtaining high quality orbital and probe data: small size and weight, very low power, low noise, exceptional flutter characteristics, and a minimum-friction design. Record-to-playback-speed ratios of up to 50:1 can be obtained with the recorder, its developers say.



*ADVANCED DESIGN of Raymond's tiny 4-lb., 7-in.-dia. tape recorder may set pattern for future satellites. It has negligible flutter, low power needs.*

Designed and built by Raymond Engineering Laboratory, Inc., of Middletown, Conn., these very-low-power, miniature tape recorders will be used in the *S-15* gamma-ray measurement vehicle (M/R Feb. 6, 1961), *S-16* orbiting solar observatory (OSO), *Tiros II* weather satellite, *S-51* international ionosphere system, and in a series of non-orbiting space probes.

Newest of the recorder series is the model 1515 developed for *S-16* under subcontract with Ball Brothers Research Corp., system manager for the satellite program.

OSO is a 425-lb. satellite which will make spectrophotometric studies of solar ultraviolet and X-ray radiation. (Scheduled for launch by a *Thor-Delta* vehicle during first-quarter 1961, it reportedly has slipped now to second quarter.)

The new unit is a time compression recorder which will be used to store data from experiments performed in *S-16*. The two recorder channels will store data from a number of sensors in a multiplexed FM system.

The program to develop this advanced recorder was begun in June, 1960, and the recorders have been undergoing additional development until recently. Final flight units are now being completed and will be delivered shortly. An earlier model (type 1447) was developed for the *S-15*.

**• Flutter reduced significantly**— Many design changes have been introduced into the new unit. Flutter characteristics of the Model 1515 recorder are exceptional and can be attributed largely to the use of a double capstan drive system which controls tension and speed of the tape across the heads.

Flutter characteristics of less than 1% peak-to-peak over a bandwidth of 0-300 cps are achieved through use of the double capstan transport drive. Raymond engineers have told M/R that new manufacturing techniques have consistently produced capstan assemblies with runout of better than 10-15 microinches.

Flutter characteristics of the *S-15* recorders are good, although more difficult to achieve since this unit does not have the double capstan design, the company said.

Since all of the recorders manufactured or being developed for satellite applications by this laboratory are for use in multiplex FM systems, elimination of noise and the reduction of flutter to low levels has been the greatest single problem.

Judicious choice of materials and components has reduced the mechanical noises in the machine to extremely low levels, its designers feel.

The use of low-noise, ultra-precision bearings is an example of the effort that has been made in minimizing noise produced by components in the machine. Type K-1-A magnesium, used as the frame material, also assists in damping mechanical noises in the mechanism.

Of the noise produced by the electrical system, amplitude modulation was a severe problem. However, extensive development of electronic circuitry has proven that amplitude modulation of 3 to 4% is practical.

**• Weighty mechanical problems**— On an overall basis, mechanical problems of the tape recorder have given the most trouble in developing the recorder for satellite applications. The tape transport must be extremely efficient in order to maintain the low power consumption levels required in satellite systems. A highly efficient (40%) motor was developed and is now widely used in all recorder applications.

Sources of friction throughout the tape transport must be kept to extremely low levels. The largest single source of friction in the tape transport is the tape loop itself, which has been reduced to tolerable limits through the use of lubricated tape. Extensive use of electrofilming and electrolizing processes have further helped in reducing the friction on rubbing surfaces.

# pace Use

**by Charles D. LaFond**

Mylar belts are used exclusively in the transmission for the tape recorder machines. They assist in absorbing pulsations transmitted through the machine members. Gearing would be intolerable since it would contribute greatly to flutter problems.

The Mylar belts in use in these recorders are necessarily extremely thin, since variations in thicknesses change the pitch line of the rotating members and produce speed changes which result in flutter in the output signal. It took a considerable development effort to produce the thin Mylar required for fabricating belts of the desired quality, exhibiting the long life needed for these applications.

• **New hybrid drive**—The low power requirement of less than 1 watt (at playback speed) for the machines is attributed largely to a hybrid DC-AC transport drive motor, also developed by Raymond. At start, it operates as a DC motor until synchronous speed is achieved. An inverter supply then drives the motor synchronously.

Extensively developed and highly reliable transistorized circuitry is used throughout to further minimize power consumption. Temperature compensation of electronic assemblies has produced a gain stability of 1 db, Raymond says.

A precision-drive capstan is located on each side of the erase-record-playback head assembly, with the lead capstan 1% larger than the trailing capstan. Both are driven by the motor at constant speed, but the larger capstan provides a differential speed between the two.

The drive system creates a constant tape tension across the heads and isolates this section of tape from disturbing forces external to the capstan assembly.

Record time for most applications is approximately 100 minutes, with playback accomplished in five minutes or less. Characteristics will be determined by satellite orbit time and the length of time the satellite is within range of a receiving station. For different applications, the range of record-to-playback speed ratios can vary from 1:1 to 50:1.

In the *S-16* recorder, maximum total power consumption during the record mode is 0.75 watt. Frequency response during the record mode is from 100 to 1300 cps which reproduces at approximately 1.8 to 24 kc. Record speed is 0.60 in./sec., while playback is accomplished at 11 in./sec.

Signal-to-noise ratio is better than 30 db and amplitude modulation is less than 10% of the carrier signal. Second harmonic distortion is less than 2%, says Raymond.

The recorder stores 300 feet of tape in an endless-loop configuration. Size of the hermetically sealed 4-lb. package is 7 in. dia. x 3 in. in diameter by three inches in height. Two data channels are provided.

Constructional characteristics include shafts mounted in preloaded, precision ball bearings. Preload values are chosen to prevent relative motion of shafts with respect to the frame. This is determined by measured vibration limits developed by booster rockets during launch.

The recorder designers stressed that materials used in the units have been selected for maximum efficiency consistent with minimum weight. Wherever possible, use has been made of standard commercial components exhibiting the high performance characteristics required by the delicate role of the recorder.

• **Future needs**—Raymond feels that the greatest single problem for future tape recorder development appears to be in the recording tape.

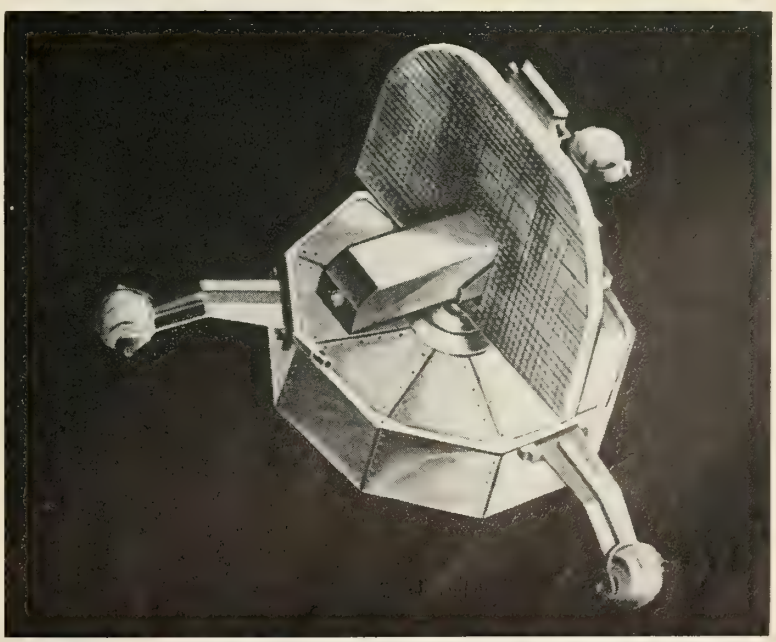
Friction reduction in the tape loop will reduce power requirements for future applications and increase tape life, yielding a longer useful satellite life. Extension of the temperature environments for magnetic recording tape is also a prerequisite for successful future applications.

Fabrication and design techniques developed by Raymond in *S-15* and *S-16* satellite programs have laid the groundwork for future satellites. Many of these techniques are now reduced to the routine rather than the extraordinary, and much of this work can be utilized in coming programs.

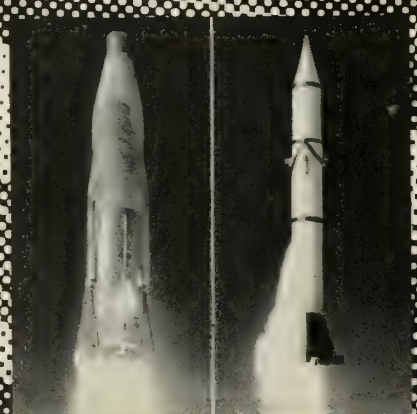
For the foreseeable future, the company intends to press its tape recorder activity in the low-power, subminiature designs for satellite applications.

Some preliminary work has been started on a similar transport designed for digital application. Some additional work is anticipated in further developing the transports to accept an even wider range of environmental conditions and maintain or improve the reliability and life of existing designs.

At the present time, Raymond is developing and manufacturing tape recorders, under a NASA subcontract, for a rocket probe in which it will be used as a delay device alternately recording and playing back signals from an RF impedance probe. ⌗



*SATELLITE RECORDER installed in base section of NASA's S-16, Orbiting Solar Observatory, will store experimental data and play back on orders from ground.*



The most proven large ballistic missiles, the Atlas (left) and Redstone (right), will launch America's Astronauts. Main-stage engines of both are by Rocketdyne.

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# AGAVE Tracking System Goes To Sea

***Cubic equipment is easily adapted to eight ships for use on both ocean ranges—and in Project Mercury***

SAN DIEGO—Cubic Corp.'s AGAVE tracking system is now being installed aboard eight instrumentation ships for use on the Atlantic and Pacific Missile Ranges and in Project *Mercury*.

Only slight modification has been required for shipboard use of AGAVE, which is a self-steering telemetry antenna system capable of acquiring targets in a large angular region and tracking them for maximum receiving sensitivity or range.

The self-tracking feature of AGAVE (Automatic Gimballed-Antenna Vectoring Equipment) makes it especially adaptable for shipboard, because no stable platform is necessary. The system can acquire and track even when a ship is pitching or rolling.

The wide-beam AGAVE system can work against any telemetry or other signal source in a missile or satellite, using a roughly angular cone ± 20° around the antenna boresight line. Cubic reports that AGAVE has tracked a 250 mw. source at ranges greater than 5000 mi.

The system already has been used at sea in tracking *Discoverer* shots, military missiles fired from Cape Canaveral and *Scout* missiles fired from Wallops Island.

• **Quadruples capability**—In the shipboard installations, narrow-beam antennas are slaved to the system and locked onto target after its acquisition by the broad-beam antenna, a 12-ft. antenna with a 20° beam width and a gain of 18 db. or better.

AGAVE is going aboard AMR's American Mariner, PMR's Joe E. Mann, Knox Victory, Nyantic Victory, Range Tracker and Skidmore Victory and aboard two *Mercury* instrumentation ships, Rose Knot and Coastal Sentry. Anti-corrosion coating for the sea-going AGAVES is provided by Magna Coatings and Chemical Corp., Los Angeles.

First installation was on the American Mariner (see photo). Shipboard operation normally is on the 215 mc. to 260 mc. band although the system can handle any standard IRIG telemetry band. If angular tracking is required, the ship's gyrocompasses can be employed for input to a computer to provide this information.

According to Cubic, AGAVE's wide-band tracking receiver can acquire and track telemetry signals at ranges up to four times as great as usable telemetry ranges.

"Even with the broad-beam pattern, overall tracking sensitivity can still be maintained in the acquisition tracking units, since its receiver can utilize narrow-band technique for significant improvements in sensitivity," says Cubic engineer Harold D. Dickstein. "Such narrow banding is possible because tracking information does not depend on reception of the entire wide-band telemetry signal."

• **Free from jitters**—Since narrow-beam systems are being directed, good wide-beam tracking accuracies are required. These accuracies are obtained by use of interferometer techniques.

This approach, according to Dickstein, produces a sum channel output free of the jitter normally encountered in sequential lobing systems. The signal presented, in addition to furnishing tracking information, provides usable telemetry data. Although the tracking unit does not have the gain of the slaved narrow-beam unit, it is said to offer a significant improvement in data reception due to its ability to keep a relatively high gain system on the target.

If acquisition is not a problem and tracking alone is desired, the interferometer tracking receiver can be applied directly to the narrow-beam antenna unit to provide a maximum gain self-directing telemetry data receiving system.

• **Strong points**—Dickstein lists these design advantages of the AGAVE system:

–Precise orientation input is not required since the system acquires on wide beam, wide angle.

–Greater range is achieved than with a narrow beam system, making it useful for tracking out to the ranges expected in future space work.

–Where a rapid slew rate is required for a target passing directly over the antenna, the system can track over the top with wide beam and then return to narrow beam, thus making it possible to use less expensive pedestals.

–A stable platform is unnecessary unless actual angle readout is required.

–It can handle any standard telemetry signal. With modification, it will handle the new telemetry bands of 1435 mc. to 1530 mc. and 2200 mc. to 2300 mc.

–Coast computers make it possible to track through deep fades and plasma sheath blackout during re-entry.

• **In operation**—The AGAVE equipment consists of the gimballed antenna system, a receiver, a servo amplifier, and a gimbal drive which points the antenna system at the target.

It combines an angle sensitive r interferometer system with a signal sensitive coherent detector loop. Unit for Project *Mercury* will work against signals in the 225 mc. to 300 mc. ban

with a frequency deviation ratio restricted to 1, and an expected drift of ± 40 kc. System sensitivity in this case is greater than –140 dbm. for initial acquisition. After acquisition, the system automatically "narrow bands" and sensitivity is improved to –160 dbm. to permit tracking at extremely long ranges even in severe signal fades.

Once the signal is acquired, the system slews itself to boresight and tracks or steers itself automatically to maintain maximum sensitivity.

The interferometer technique used involves phase comparison at the rf frequency with hybrid rings. The resultant output or error data does not depend upon phase stability to preserve boresight information. According to a report made by Dickstein to the National Telemetering Conference, the technique relaxes circuitry phase tolerances normally required for accurate boresight data in interferometer systems. The over-all servo loop gain which is affected by phase errors is, he says, sufficiently insensitive to errors to tolerate phase variations up to ± 35°.

AGAVE uses four helical antenna elements mounted as azimuth and elevation interferometer sensors. A phase difference between each pair of elements is encountered whenever the signal source is away from boresight. The two signals are compared in a hybrid ring which produces two outputs—a vector sum and a vector difference. Subsequent coherent detection and measurement of the sum and difference outputs yields the required sensitivity and tracking accuracy.

Servos drive the four-element antenna assembly in azimuth and elevation to eliminate the phase difference in each pair of elements. After lock-on, the assembly tracks the source by maintaining both phase nulls.

Dickstein says the use of hybrid rings—stable, broadband, non-tunable units—prevents introduction of a boresight error from any phase delay variation in subsequent circuitry.

• **For sensitivity**—Use of coherent detection and narrow-band techniques to maximize system sensitivity is explained by Dickstein this way:

The only data of importance to the tracking system is the amplitude and sense of the error signals in the difference channels. These signals are passed through narrow-band filters to prevent low-level noise saturation in the error detectors. The first if. is 35 mc. to provide good image rejection in the 225 mc. telemetry band. The second if. is 2.2 mc. It is frequency-stabilized by using a voltage-controlled oscillator, (controlled in the sum channel), for local oscillator injection to the 2nd mixer. Since the incoming signal usually drifts over a large range, this second local oscillator compensation is needed so that the second if. is stable within the crystal filter passband.

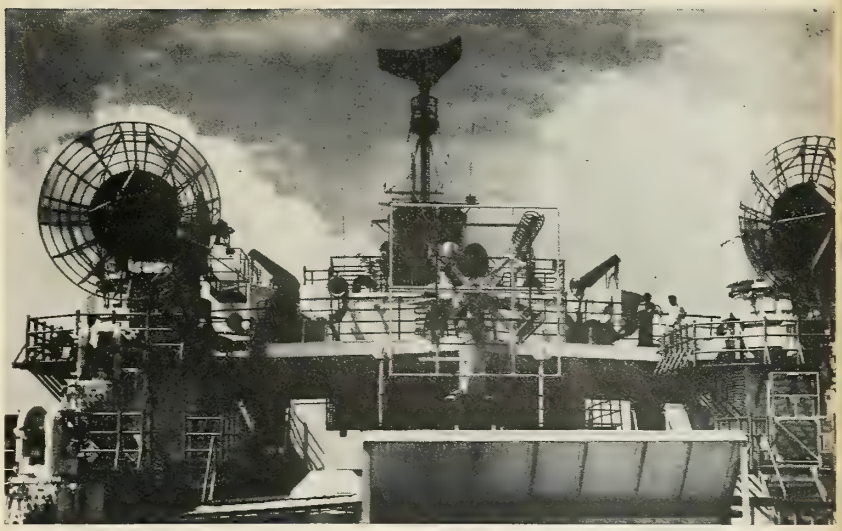
The voltage controlled oscillator system utilizes coherent detection techniques to (1) "acquire" the incoming signal, even if signal-to-noise ratio is very low, (2) "push" the error channel outputs to the crystal filter passband, (3) pass at least one pair of sidebands and convert this energy to carrier frequency and (4) with the error signal outputs thus obtained, drive the pedestal to acquire the target in space.

After acquisition, there is no need for further searching and the system can be "narrow banded" to a degree compatible with overall receiver and servo loop bandwidth. This narrow banding is accomplished by relay operation, controlled by the AGC feedback output which will energize the relay only when carrier lock takes place.

Further details of the system can be found in a paper delivered to the 1960 National Telemetering Conference by Dickstein and John T. Underhill.

• **Mercury assignment**—Cubic already has delivered AGAVE systems to Bendix Radio Division of the Bendix Corp. for installation at sites around the world in the Project *Mercury* program. They will be used to provide primary acquisition of the capsule as it appears above the radio horizon. After acquiring the capsule, AGAVE through its servo outputs will direct AN/FPS-16 units, which are too narrow for initial acquisition, to the same point.

AGAVE then will provide in itself a self-tracking data receiver system and also serve as the master tracking unit for other receiving antenna systems slaved to it. The *Mercury* units use a quad-helical array built by Canoga Division of Underwood. ❖



*CUBIC'S AGAVE was first installed on ship in the Atlantic Missile Range's instrumentation vessel, American Mariner. Quad-helical antenna unit is in center.*

## New GE Flight Control System Being Evaluated

A NEW, SELF-ADAPTIVE flight control system is undergoing evaluation tests on North American Aviation's *X-15* simulator.

Called GESAC, it differs from conventional flight control systems in that a frequency sensor is used to measure continually the aircraft response and system gain is adjusted automatically to attain the desired response level.

Developed by General Electric's Light Military Electronics Department during the last two years, the system is being tested under a joint effort by the Air Force, North American and G.E.

The evaluation program has reportedly shown GESAC's ability to accomplish its control task over a wide range of flight conditions.

The self-adaptive method of attaining invariant response, says G.E., also eliminates the need for external information such as air data for gain changing. Additional benefits gained, the company says, are reduction in system design and in flight test time.

The GESAC system successfully passed a recent flight test program when installed in a Convair F-106 Delta Dart at G.E.'s flight test facility in Schenectady, N.Y., under a Navy contract.



*An exclusive M/R interview . . .*

# Lee Has Big Propulsio

***Douglas subsidiary aims at major role in liquid space energy work; colloids will get early emphasis***

LONG BEACH, CALIF.—Astropower, Inc., the new propulsion subsidiary of the Douglas Aircraft Co., already has several proposals in the hands of the Defense Department and the National Aeronautics and Space Administration.

No details are available, but it is known that the firm plans to avoid solid-propellant rocketry and work only in the specialized liquid propellants of the chemical rocket field.

Among the early hardware contracts Astropower expects to bid on will be components on the *Rover* nuclear rocket. Such items as pumps, nozzles, actuators, control systems, feed systems and similar hardware are in Astropower's field of interest on *Rover*.

Astropower was formed last Nov. 7. Company president Y. C. Lee (photos) has made it clear the firm hopes to become a major factor in primary propulsion and auxiliary power for space vehicles. He is laying out a careful program to skim the cream of contracts in this space energy field.

Astropower intends to specialize in various electrical propulsion systems, nuclear propulsion, solid state devices and systems for nuclear auxiliary power (SNAP), as well as related fields in the space sciences. (M/R, Jan. 2, p. 39)

Lee told M/R that in reactor technology, Astropower plans to conduct research and development in gaseous core types, but has no present inclination to get into the solid core reactor programs such as the *Rover* and *Pluto* projects. Any reactor work done by the company will be aimed at propulsion and auxiliary power fields, according to Lee.

• **Emphasis on colloids**—In electrical propulsion, the colloid, ion and arc-jet types will be studied, with initial emphasis on the colloid system. Colloid, or heavy particle, acceleration is preferrable for manned, long-distance space flight, Lee feels, because of shorter time-to-destination. High thrust/weight ratio engines will be worked on with a view toward providing higher acceleration levels than ion systems offer.

In a long voyage utilizing low-acceleration ion engines, Lee said, the additional equipment required to support the crew for the longer period outweighs the extra equipment required by a colloid system that would get the mission accomplished in shorter time.

He emphasized that the argument holds true mostly for manned missions, and indicated that ion systems would also be studied by Astropower. Specific areas of investigation include source problems, high current density through use of a cavity source, and a better source in terms of yield and ease of working with water.



*Y. C. Lee, boss of Astropower,*

The colloids, however, appear to take first priority in the electrical field, with present accelerations of $10^{-3}$g now obtained in lab work. The ultimate level of the engine's efficiency is governed by power technology. In this light, Lee noted, power losses with the heavy particle system are less than with the ion system, and in addition, ion systems work at a higher temperature —about 1500°F. The colloid engine, working at ambient temperatures, has an advantage in this respect, he said.

• **Neutralization**—Another area of advantage for the colloid system is the neutralization problem now plaguing

# lans for Astropower

ion engine makers. The "nagging backache" of the ion rocket, neutralization is expected to trouble the heavy particle system to a much less extent than ion types. Sputtering troubles are about the same for both systems and the key to this appears to be in the beam focusing, Lee said.

In the economic aspects of the electrical propulsion field, colloidal propellants are much less expensive than ionizing propellants such as cesium, which is selling at $900 per pound.

Summing up the advantages and disadvantages of the two systems, Lee concluded with the belief that an electrical propulsion system using the



*ig contracts from DOD, NASA.*

heavy particle approach could be brought to the same state of development as the ion engine, while costing less and taking less time.

"For the same amount of money as the government has now spent on development of ion engines," he stated, "we could have had a colloid system much further along."

He expressed little hope, however, that any such sudden funds would appear.

• **Other efforts**—In its research and development work on arc jets, Astropower will probe the recombination of hydrogen in nozzles as the primary problem. As a critical performance problem, the recombination difficulty will come in for a large share of attention.

Chemical propulsion efforts will be limited to those special liquid fuels and oxidizers which, when combined with a third component, will yield very high impulse while retaining handleability.

A three-component system designated "Hyfox" will be Astropower's so-called tribrid combination, consisting of liquid hydrogen, liquid oxygen and a third component to increase performance. Such an additive might be any metal: magnesium, lithium, aluminum or other material in a jelly or slurry form. The slurry can be contained in a separate tank or introduced into the hydrogen tank.

Such storable propellants as pentaboranes will also get some attention, as will various boron compounds.

In the field of internal power for space vehicles, Lee expressed considerable interest in fuel cells, nuclear power packages, solar sources and solid-state devices—notably thermoelectric types. Work on thermoelectric material formulations will be carried out, with expectations of achieving 15% efficiency in operation.

Other power equipment and power source systems will be studied with the same eye to specialization.

Further along the road of product development and corporate planning, Lee hopes, Astropower eventually will turn out some consumer products, especially in power applications, as a result of work in space research.

"We have all the necessary financing arrangements made with Douglas to keep us going for quite a while," Lee said, "and we could keep about 450 people busy for several years even if we received no contracts at all. But if I thought we would go along for any length of time without getting contracts, I wouldn't be with the company."

Temporarily headquartered at Douglas Aircraft Co.'s Long Beach facility, Astropower expects a master plan for its new permanent home to be completed about mid-March by Wm. L. Pereira & Associates. The new site will incorporate all administrative, engineering, research and test facilities. No official announcement has been made as to location, but the site will most likely be in the area of Newport Beach, Calif., south of Los Angeles. ⌗

## Three Firms in Running For Saturn Tanks Award

WERNHER VON BRAUN will choose between Boeing, Chance Vought and Martin for a $2¼ million contract to supply 42 propellant tanks for *Saturn* boosters 6 through 10.

Von Braun's Marshall Space Flight Center, National Aeronautics and Space Administration, will manufacture the tanks for the first five *Saturns* in-house and will continue to assemble the boosters for *Saturns* 6 through 10. After that, the entire booster stage will be constructed by an industrial contractor.

Delivery of the 70-in. tanks will begin in mid-1962. Boeing, Chance Vought and Martin were chosen from 18 bidding on the contract. Von Braun will choose the winner after NASA negotiates terms with all three.

## NASA Engineer Patents Winged Rocket Vehicle

AN ENGINEER on Wernher von Braun's staff has obtained a patent on a vehicle called the "Rocopter," which combines a rocket booster and a compartment with rotary wings for re-entry.

Friedrich G. von Saurma, of the *Saturn* Systems Office at the Huntsville, Ala., center of the National Aeronautics and Space Administration, invented the vehicle, which has wind-rotatable blades that gradually open as it travels along a ballistic trajectory in space, after separation from the booster. The airfoils' pitch could be changed to vary the rate of deceleration.

The Rocopter's gliding angle and azimuth would be regulated by ground radio control or, if men were aboard, by manual steering. Von Saurma suggested that the vehicle might be used by the armed services for rapid reinforcement and supply of isolated troops or scientific units. A civilian application, he added, might be very fast transport of mail, freight or passengers over long distances.

Von Saurma, who was technical director of the test and training center for *V-1* missiles at Peenemunde from 1943 until the end of World War II, came to the United States in 1953 and has been a citizen since 1959.

## Recording Liquid Test Data

CANOGA PARK, CALIF.—A new computer reporting system at Rocketdyne division, North American Aviation, makes it possible to record automatic processing of data generated by liquid-propellant rocket engine tests in a unified system on a digital computer.

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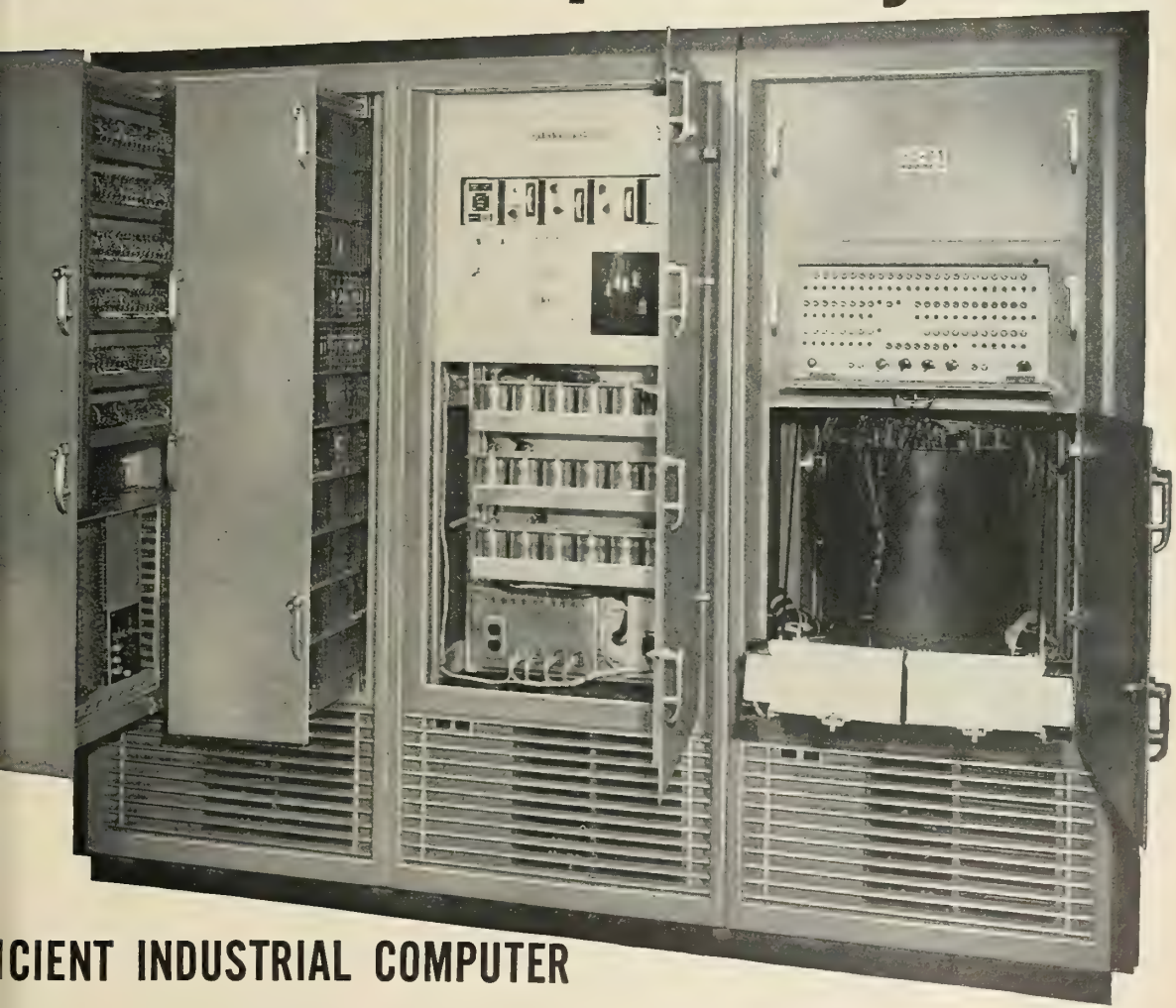
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# Toward Safety in Handling of Propellants

by H. A. Volz
*Safety Director*
*Callery Chemical Co.*

THE RAPID DEVELOPMENT of propellant technology is generating a unique challenge: establishing safety standards for the handling of these high-energy materials.

Notable progress is being made even though the art and science is relatively new and the materials' properties are not usually completely known.

The formula used in propellant handling programs at Callery is basic to all safety procedures. If everything possible is known about the components in a given hazardous situation, conditions can be formulated to prevent injury to the involved personnel. In a sense, a safety program is a proving ground for both the hazard and the required protection that must be considered for large-scale production.

The major points in propellant fuel handling are toxicity and fire and/or explosion dangers.

The toxic nature of a propellant will vary with the particular substance. Taking pentaborane as an example, the three main phases in a toxicity program are detection, protection and treatment. Studies have shown that an instrument could be developed for detection of pentaborane vapors in the range of 200 parts per billion, a safe concentration; Kel-F or teflon clothing is necessary to protect the wearer because it will withstand pentaborane exposure without serious deterioration; respiratory equipment must be of the self-generating or air-supplied type.

There are no antidotes for overexposure cases. Each case would be treated symptomatically using muscle relaxants and anti-convulsive agents as indicated from the developing indications.

Blood chemistry tests based on protein bound boron will indicate definitely if an exposure has occurred; they are used routinely on all personnel who show clinical symptoms which may be related to overexposure.

• **Blast problems**—In the appraisal of fire and explosion hazards, the questions that must be answered are more numerous and complex. Typical are the following: (1) Is the material spontaneously flammable? (2) Does it make other materials pyrophoric? (3) Can you control or extinguish fires involving this material? (4) Will it detonate by impact? (5 )Will it react with other materials in its environment to produce detonation?

Tests always begin with micro-quantities of the material under study. A great deal may be known about the substance—or nothing at all. To find out how sensitive it is to impact, a tiny amount is placed in a standard container and subjected to a drop-weight test. To find out how easily a liquid propellant is detonated, a small amount is exploded with a standard charge. To measure the effect of heat on a given material, micro-samples are run through a thermal stability tester.

Finally, to measure the explosive force of a propellant, one method used is the dent-plate test, which gives a direct reading in millimeters of the depth of dent caused by the explosion. Most of the micro-testing is carried out in a laboratory specially designed for this purpose. A maximum of five persons are permitted in this building at one time, and all personnel wear the safety clothing, head and eye protection, and respiratory apparatus required for the material in use and operations taking place.

• **Range safety**—For larger scale testing, a series of bunkers have been erected on a "firing range" in open areas. In one typical setup, it is made impossible to complete firing unless shunts are first removed from two widely separated points, thus energizing the circuit through a 30-second delay alarm system. For testing of fuel properties under actual firing conditions, controls are housed outside of the test area behind a two-foot thick reinforced concrete wall. Blast force to the other side of test area is cushioned by heavy steel cable curtains.

The hazards of propellant fuel handling and production are being lessened with each new advance in safety know-how. We can provide the physical protection to guard against human error, but our best chance for success in safety lies in the complete acknowledgement and understanding of all the hazards that face us. ⌗



*PROPELLANT material explodes in detonation tests. Remote controls are located outside the steel-walled cell.*



*DENT PLATE tester measures explosive strength of samples. Probes are safety shunts to avert accidental detonation.*

# Consumable Case Rocket Described

by Frank G. McGuire

SALT LAKE CITY—A consumable-ase solid rocket promising to add 700 autical miles to ICBM ranges was mong developments disclosed at the merican Rocket Society Solid Propel-nt Conference here.

A discussion of plug cluster nozzles esigned to reduce or eliminate some resent difficulties with other types also rew high interest.

Launch of the *Minuteman* ICBM t Cape Canaveral within two minutes f the conference opening here pro-ided as dramatic and resounding a avel as any chairman could have sked—particularly since the meeting rew 650 engineers and scientists to the ackyard of two companies producing ocket motors for *Minuteman*.

Two Soviet Embassy officials turned p at the meeting. (See box and edi-orial.) Their presence was taken by ome as an indication the USSR lags n solid rocket technology. Two liquid ropellant meetings held in the past wo years were ignored by the Soviets. But they went to considerable trouble o attend the solid rocket conference ere and the one last year in Prince-on, N.J.

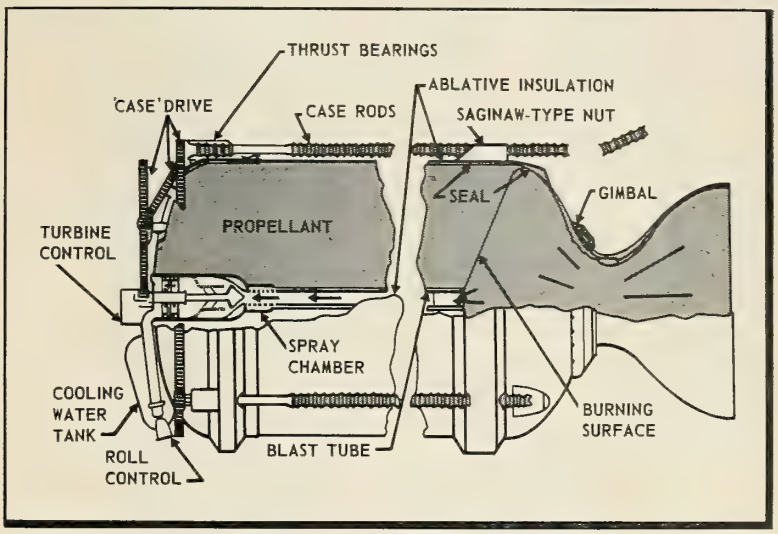
During this conference, the Soviet fficials made a careful selection of echnical papers and attended the tech-ical sessions, with the exception of he classified session on *Minuteman*.

The consumable-case solid-propel-nt rocket motor discussed by A. N. axter of Space Technology Labora-ories was said to have numerous ad-antages. Included in these would be 40% greater burnout velocity, a ominal burnout mass ratio of 30, an ncrease of 700 miles in ICBM ranges, continuously jettisonable case, case eight one half of conventional weight, solid film cooled nozzle, inherent roll ontrol capability, and an insignificant il-off time and impulse.

In application, Baxter recommends e of the unit as first stage for medium-zed ICBMs, or as second stage for uch larger vehicles.

Studies of the consumable case cket (CCR) were carried out using 200,000-lb.-thrust rocket with a eight of 50,000 lbs. and chamber essure of 700 psi as a basis for calcu-ion.

At a quick glance, the CCR looks like this: a solid cylinder of propellant burning at its aft end, a fore-end dome, a converging-diverging nozzle, connecting rods to maintain appropriate spacing between fore-end and nozzle, and a drive mechanism to advance the nozzle as the burning surface moves forward.




*CUTAWAY DRAWING of the consumable case rocket (CCR) discussed by STL's A. N. Baxter at ARS meeting. Spur gear drive shown was called inferior to two other types.*

The propellant charge is surrounded by ablative material and radial stress is resisted by hoop tension in the nozzle only, while axial stress is resisted by the connecting rods. A blast tube is located axially through the center of the grain, and exhaust gases are carried through this tube to drive a turbine which powers the nozzle-advance rods.

The ablative material surrounding the propellant charge is gradually carried along the inside of the nozzle by the advancing drive mechanism, thus providing solid film cooling of the throat.

Three types of drives are considered for operation of the nozzle-advance rods: Spur gear; bevel, hypoid or spiroid gears; and a worm gear. Various design characteristics of each type of drive were discussed in the paper. Least desirable of the three types, according to Baxter, is the spur gear.

Performance calculations used in the study were conservative, and the STL author suggested further advantages possibly to be gained from a fabrication, cost and logistical standpoint. These include potential characteristics thought out of reach of solid rocketry to a great extent.

A restart capability could be included in the design by locating an inert section of propellant across the end-burning grain. When this section is reached by the combustion surface, thrust is terminated. A timing device working with a restart system could re-ignite the propellant after the suitable coast phase is over.

Auxiliary power capability is inherent in the turbine mechanism used to advance the nozzle assembly, and would be in addition to use of the same exhaust gases for roll control.

Tail-off impulse would be insignificant, according to Baxter, and thrust termination would be easy and instant. Severing the connecting rods which take up the axial stress at a precise instant would cause the nozzle assembly to be blown away from the rocket, and the sudden pressure drop would effect immediate combustion cessation.

Recoverability of the hardware was also discussed, as was nearly 100 percent loading density, "case" repairability, nonpropulsive and nonexplosive characteristics in event of fire, thrust level adjustment without low efficiency

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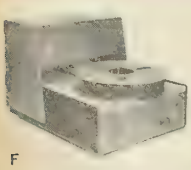
**C. This is an improved version of CEC's most famous Recorder/Reproducer, the GR-2500, which handles Analog, FM, PDM, CM and digital modes.** ***Bulletin CEC 1576-X8.***

**D. For critical data analysis, depend on CEC's new GL-2510 Continuous-Loop Recorder/Reproducer. Six tape speeds from 1⅞ to 60 ips... 14 Analog, FM or PDM plug-in amplifiers.** ***Bulletin CEC 2510-X8.***

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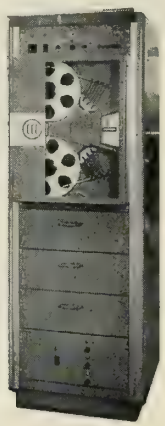
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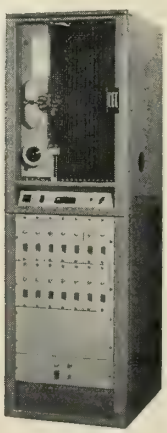

F


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A


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performance, and the other advantages.

• **Plug cluster nozzles**—In a design intended to reduce or eliminate both the inefficiencies suffered by conventional rockets during altitude changes and the problems associated with annular plug-nozzle engines, three authors from Pratt & Whitney described a cluster of rocket engines grouped about a truncated plug.

The arrangement utilizes relatively small rocket engines grouped about, and tilted toward the axis of, a truncated plug of variable length. With certain design characteristics incorporated, the cluster produces more thrust than the sum of the individual rocket chambers.

**SALT LAKE CITY—Efforts by two Soviet Embassy officials to take a look at several major facilities of the Minuteman program were blocked here during the American Rocket Society's conference on solid propellants.**

**Gen. Mikhail N. Kostiuk and Arkady Y. Golosky attended the meeting after pre-registering by mail. They signed up for all field trips to be conducted, including trips to the Minuteman assembly plant and train facility at Hill AFB; Hercules Powder Co., makers of the Minuteman third stage; Thiokol Chemical Corp., manufacturers of the Minuteman first stage; Marquardt Corp., producers of ramjets for Bomarc; and Sperry Utah Engineering Laboratories, prime manufacturing contractors on Sergeant.**

**Permission for the vists was flatly denied.**

**The general and his aide were refunded $4.75 each by the American Rocket Society.**

A. Chamay, J. J. Horgan and D. Migdal reported test results showing the plug cluster nozzle to be similar in many respects to the plug nozzle, and both being superior to the conventional bell chamber engine. During tests, the plug cluster nozzle used UDMH and nitrogen tetroxide propellants at a chamber pressure of 300 psia. The authors also pointed out applications to solid propellants.

Most attractive using between 12 and 50 individual nozzles, the plug cluster operates over a wide range of pressure ratios without inheriting the serious mechanical problems of its cousin, the annular plug nozzle. Studying the design, P&W engineers evaluated efficiency thrust vector control, reliability, hardware needs, and other parameters—concluding that the concept has considerable promise.

Problems still to be faced in the concept include propellant physical and ballistic properties, aerodynamic roughness, turbine speed control, and similar hardware difficulties.


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Although the plug nozzle annular engine made its debut some time ago amid great fanfare, its use has been somewhat restricted to experimental testing because of mechanical problems associated with the design. Since the plug cluster nozzle design uses conventional rocket engines already developed—merely grouping them about a plug—there is little unknown about the engines themselves.

At first, the use of a number of engines seems to pose a reliability problem, but the authors state that the design incorporates a "built-in spare engine." The utilization of already-developed relatively small engines rather than embarkation on a new development program was advocated, in the interests of reliability.

Hardware used in testing the design consisted of two units, one with 12 individual nozzles, and another with 24 nozzles. Tests were conducted over a wide range of pressure ratios, simulating atmospheric conditions from liftoff to exit from the atmosphere.

Simultaneously, an all-external expansion plug nozzle designed with the same area ratio and an annular throat was tested as a control device.

A number of plug lengths were tried, simply by truncating the plug and using the same contour. Little difference in performance was noted, even after extreme shortening of the plug.

• **Other papers**—In addition to the papers on consumable-case rockets and plug cluster nozzles, the ARS meeting heard about an unconventional grain configuration proposed by William C. Stone, of Rohm & Haas Co., to compensate for erosive pressure peaks during combustion.

Stone proposed a slotted tube grain design intended to reduce the initial burning surface, using a progressivity ratio greater than unity. Using the slotted grain design, he said, progressivity ratio adjustments are possible by simple adjustment of the slot length.

Writing on metal additives to solid propellants, A. W. Blackman and D. C. Kuehl of United Aircraft Corp. cite advantages to be gained through use of binary light metal mixtures and alloys, rather than pure metals.

What the authors describe as "appreciable increases in theoretical performance" is signified by an example of adding the bimetal lithium-beryllium to a propellant of 15% hydrocarbon binder, 70% ammonium perchlorate, and 15% metal additive. The result is 12 seconds increased specific impulse over what would result from a pure beryllium additive. In addition to the impulse increase, combustion instability is reduced.

Also covered in the research were lithium, aluminum, and other metals. ❖

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# Gaseous Laser Holds Vast Promise

***Bell Labs development will exploit data-handling capacity of coherent light—broad applications seen***

BELL TELEPHONE Laboratories has developed a continuous-output coherent optical maser or laser. The new device promises magnitude increases in future data-handling capacity for communications.

Employing a gaseous medium, the approach is considered vastly more sophisticated than more conventional systems which use solid-state masers for optical pumping. Output from such systems is coherent, but pulsating.

The output from Bell Labs' laser (light amplification by stimulated emission of radiation) is in the infrared portion of the frequency spectrum. Its coherent radiation beam is highly directional, having a spread less than one minute of arc. A gaseous laser on earth, operating through a suitable telescope, could send a beam to the moon that would cover a spot smaller than one mile in diameter, the scientists say.

• **BTL's method**—A helium and neon gas tube is used, and an electrical discharge flows through it. Helium atoms are super-excited to an unusually high energy level. Neon atoms in the mixture absorb some of this energy during a resulting collision process; these can then be stimulated to radiate the added energy on demand.

Contained in a tube, the beam is reflected alternately and with increasing intensity throughout the length by semireflecting end plates. Some of this beam is transmitted through the end plates forming a very narrow beam output of coherent infrared light.

The narrow spectral line width of the output beam is 0.00001 as wide as that from other coherent light sources. BTL reports that this property has, for the first time, made it possible to observe difference-signals at radio frequencies between two optical lines.

• **A low-power device**—Output power is roughly 0.01 watt; input for the electrical discharge is in the "tens-of-watts" range, Bell says.

At this level of operation, the tube is so cool that it can be held in the hand without discomfort. The level of operation can be increased by using larger-diameter tubes.

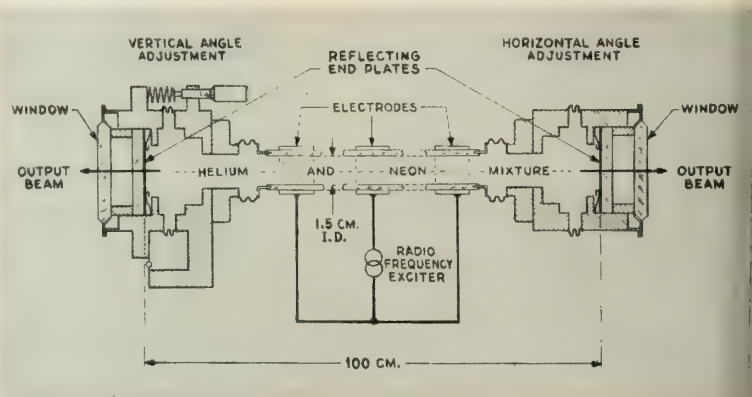
Gaseous lasers and solid-state lasers are expected to complement each other in their applications. The latter is essentially a high-power device, and Bell feels that it will have important uses even if limited to pulsed operation.

Since the neon atoms can radiate energy from almost any one of four upper energy levels to one of 10 intermediate levels, up to 30 discrete frequencies can be emitted by the laser, depending on the specific mode of operation.

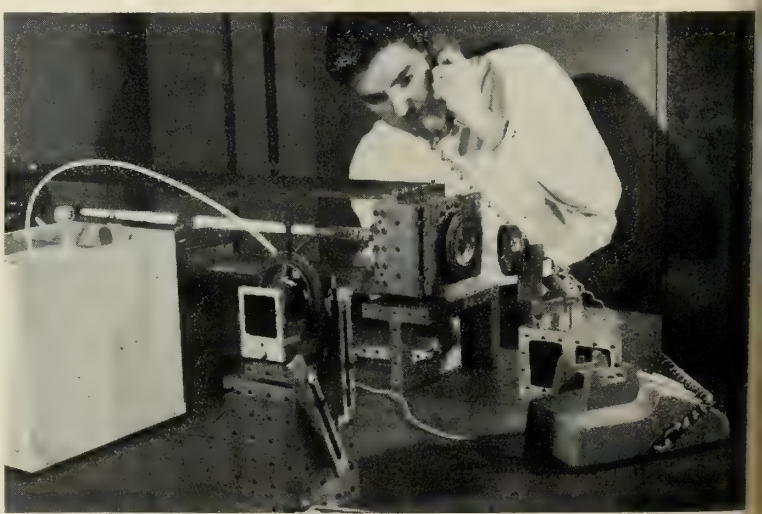
• **Broad frequency range** — The range of possible wavelengths lies between 9000 and 17,000 Angstroms. Present laboratory models, according to BTL, have operated at five different wavelengths between 11,000 and 12,000 A.

The output line width is far sharper than that of ruby lasers. Light emitted by ruby devices is about 60 times narrower than the ruby's normal fluorescence.

Normal fluoresence from the helium-neon mixture is already that narrow, and laser action narrows the beam more than 100,000 times more. Thus




*GASEOUS LASER technique for impressing telephone talks on coherent IR beam*



*CUTAWAY VIEW of Bell Labs' gaseous laser. From an input of tens of watts for the electrical discharge, a 0.01-watt output can be obtained.*

he line is thousands of times sharper han the best spectroscopic lines avail- ble in the optical region, Bell scien- ists assert.

It is expected that different output requencies may be produced using ther gas mixtures with comparable uccess to that of the helium-neon mix- ure.

• **Applications equally broad**—The aseous laser should provide physicists ith an immensely useful tool. For xample, the narrowness of the line ill afford an accuracy hitherto unat- ainable in spectroscopic work at these requencies.

Another possible application of the evice is the measurement of distances f many miles with extreme accuracy. ontinuous laser action, moreover, is orcing renewed interest in the whole ield of gaseous-discharge physics.

Communication engineers have had n urgent need for a continuously op- rating generator of coherent optical requencies. The wide bandwidths asso- iated with carrier frequencies in the R portion of the spectrum could pro- ide a vehicle for heavy data-handling apacity.

BTL scientists indicated they have een experimenting with several meth- ds of modulating a signal on an opti- al carrier. As an initial experiment, in December last year they impressed a elephone conversation on a laser sig- al by using a Kerr Cell.

Broadband modulation has been ccomplished at frequencies up to 60 c, they said, and other modulation chemes may result in systems operat- ng as high as several thousand mega- ycles. ⁂

## Autonetics' Minuteman Test Area Highly Stable

DOWNEY, CALIF.—Accurate testing f *Minuteman* missile guidance systems emands sensitivity of a degree never efore required of inertial navigation quipment.

Engineers at Autonetics division, orth American Aviation, have de- gned two devices which cancel out ffects of earth trembling and provide ie most stable area possible for testing *Minuteman* equipment.

One device is a level detector which actually a super-sensitive, electronic ismograph. The detector weighs about ) lbs. and is the size of a portable pewriter. Its core is half an inch thick id about as round as a quarter. It orks on two axes compared with a ismograph's one and is capable of easuring earth movement to millionths an inch, according to Autonetics.

The detector is placed on a 7000-lb. rizontal slab of granite. ⁂




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| | | R9608-001 | R9608-002 |
|---|---|---|---|
| TYPICAL ELECTRICAL DATA | Output (volts/1000 rpm) | 7 (typical) .5-30 available | 2 |
| | Rated Speed (rpm) | 3600 | 5000 |
| | Linearity (% to 3600 rpm) | .07 | .1 |
| | Winding Resistance (ohms) | 125 | |
| | Output Impedance (ohms) | — | 36 |
| | Ripple Voltage | 2% above 100 rpm | 2.5% at 3600 rpm |
| TYPICAL MECHANICAL DATA | Friction Torque (in. oz.) | 0.25 | 0.25 |
| | Rotor Moment of Inertia ($gm\text{-}cm^2$) | 7 | 8 |
| | Weight (oz.) | 5.5 | 5 |

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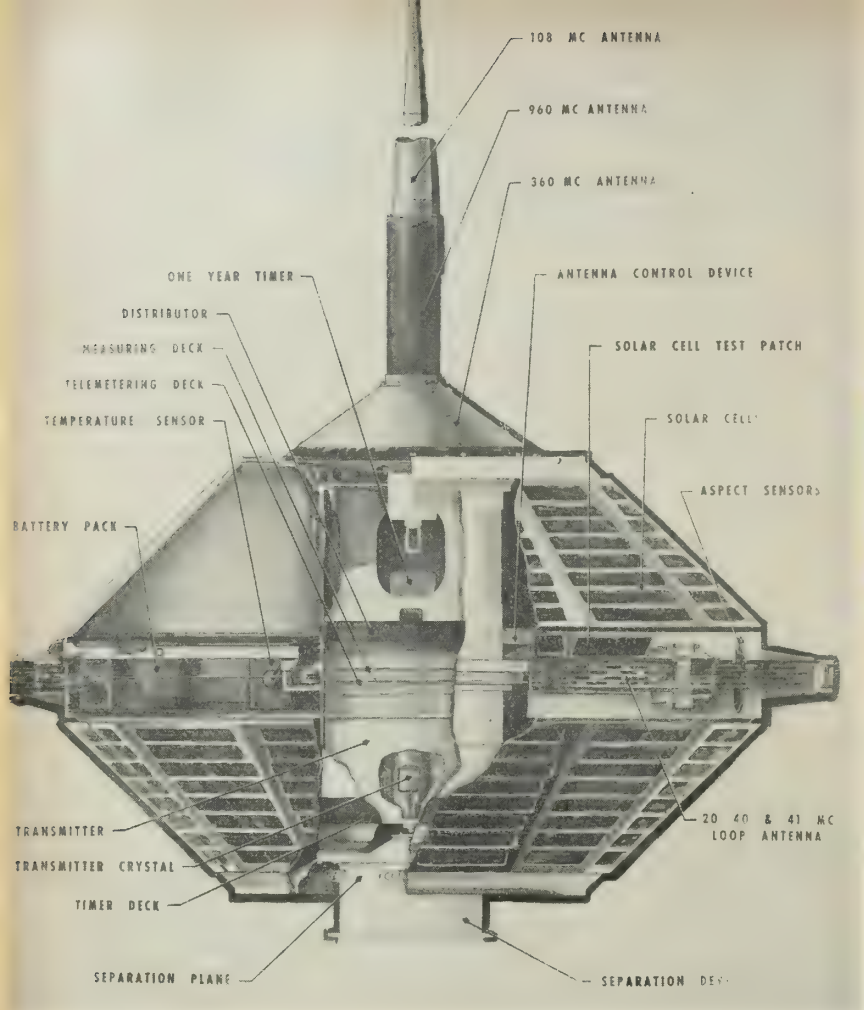
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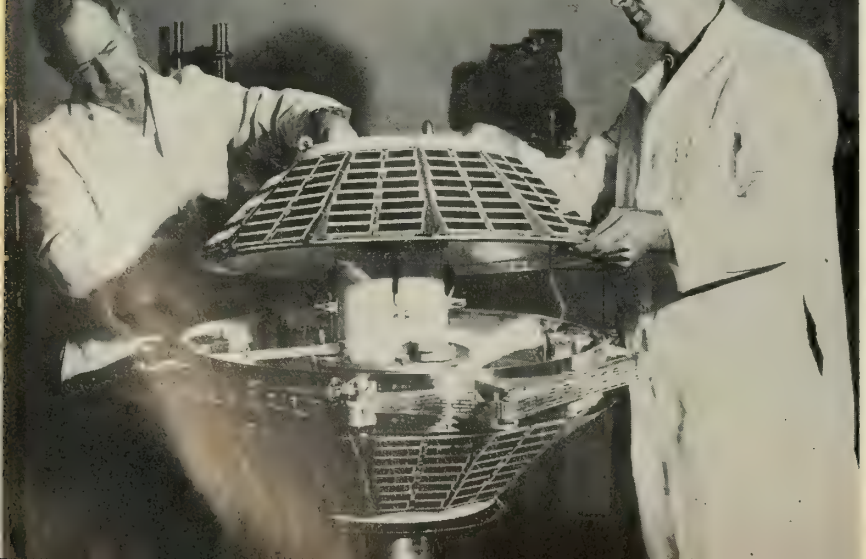
# NASA's S-

***85-lb. package will ri***
***Delta vehicle into orbit***
***intensive study of partic***
***in near space***




**ABOVE:** *Schematic design of NASA's S-45 ionospheric beacon satellite, scheduled for launching by a Juno 2 vehicle from Canaveral last week. Shot was scrubbed.*

**BELOW:** *Workers at NASA's Marshall Space Flight Center put together the main body of the S-45 satellite, designed to probe the ionosphere with six radio beacons.*



NATIONAL AERONAUTICS and Space Administration plans to launch satellite *S-3* in about five months. This is an 85-lb. satellite that will make the most concentrated investigation to date of radiation and energetic particles in the space near the earth.

"We are trying to get as much as we can pack into one satellite," says Morton Stoller, in charge of satellite and sounding rocket programs on the staff of NASA space flight chief Abe Silverstein.

Current plans calls for at least 10 experiments aboard *S-3*, assuming that all can be packed into the weight and space limitation, and that the total power drain will not exceed about watts.

A *Delta* vehicle is to launch the satellite into a highly elliptical orbit with perigee of a few hundred miles and apogee of 30,000 to 40,000 miles. Solar-cell paddles will be folded down over the final-stage *Altair* and bound with nylon cord. A pyrotechnic cutter will release the vanes when the craft is in orbit.

• **Planned payloads**—These experiments are scheduled to be aboard:

–A solar proton analyzer, to register particles in the 200 ev-20 kev range, by Michael Bader of NASA Ames Research Center.

–A flux-gate magnetometer, sensitive to 1000 gammas, by Laurence Cahill of the University of New Hampshire.

–A pair of cadmium sulfide cells, one detecting protons and electrons with energy above 100 ev and the other with a magnetic "broom" that sweeps out electrons in the 100-500 kev range but lets protons through, by Brian O'Brien of the State University of Iowa.

# atellite to Investigate Radiation

**5 satellite launch-post-ed last week—to study osphere in cooperative rt**

–Two Geiger counters, one measuring the total count of 40-55 kev electrons, protons with energy above 50 mev and electrons with energy above 10 mev; and the other registering only protons above 50 mev and electrons above 10 mev, by O'Brien of SUI.

–A third Geiger counter registering protons with energy above 20 mev and electrons with energy above 2 mev.

–A double scintillation telescope measuring the total cosmic ray flux of fast protons, with energy above 700 mev, and a differential energy spectrum of regular protons in the 70-750 mev region and low-energy alpha particles, by Frank McDonald of NASA's Goddard Space Flight Center.

–A scintillation counter measuring protons in the 1-40 mev region and electrons in the 100 kev-5 mev region, by McDonald of Goddard.

–A pair of Geiger counters, one measuring electrons with energies over 300 kev and protons with energies over 7 mev, and the other measuring protons with energies over 75 mev and electrons with energies over 8 mev, by McDonald. A particle that registers on both Geiger counters must be a cosmic ray with energy over 75 mev.

–A scintillation detector for ions in the 100 kev-1 mev region, and electrons in the 10-100 kev region, by Leo Davis of Goddard.

–An unshielded solar cell, to compare its performance with the radiation measurements.

The magnetometer was added for the first time to a radiation experiment to that radiation levels could be correlated with magnetic field variations.

Numerous deductions can be drawn from comparisons of simultaneous readings. For example, by subtracting the reading of one of the O'Brien Geiger counters from the other, it will be possible to get a reading of 40-55 kev electrons—which the Iowa group considers a highly significant reading for the Van Allen belt.

Stoller said the solar-cell damage experiment is especially important because, to date, there just isn't enough information to decide how much damage the Van Allen belts do. ⁂

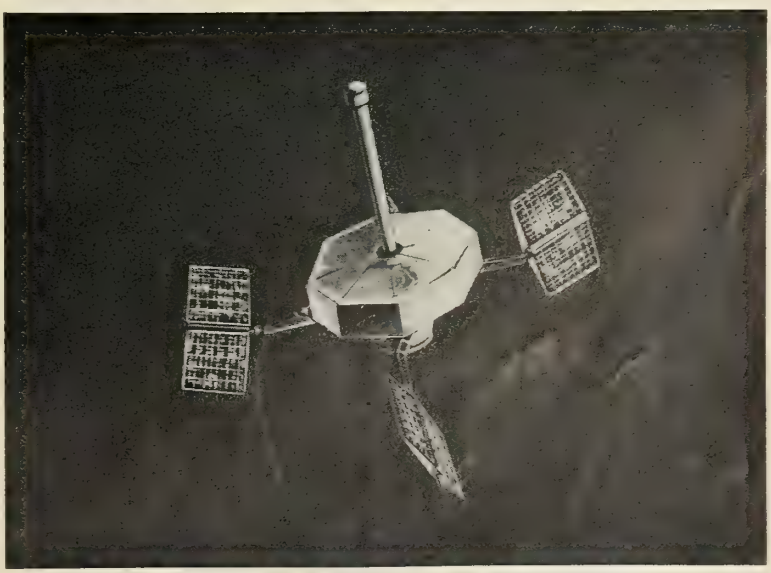
## S-45 to be Tracked by New Zealand

A NEW ZEALAND research station and four U.S. scientific groups were set to cooperate with the National Aeronautics and Space Administration late last week in studying the ionosphere with the *S-45* beacon satellite.

The 74-lb. spacecraft, to be launched by a *Juno II* vehicle, carried transmitters for operation on six frequencies —20 mc, 40 mc, 41 mc, 108 mc, 360 mc and 960 mc. Ground stations can determine characteristics of the ionosphere by studying such signal characteristics as polarization and Doppler shift.

New Zealand has a particular interest in the ionosphere because its remote position in the world makes it particularly dependent on long-distance radio transmission. Its Seagrove Radio Research Station, part of the physics department of the University of Auckland, participated.

Other participants were Pennsylvania State University, University of Illinois, Stanford University and the National Bureau of Standards. Penn State established an equatorial recording station near the magnetic equator at Huancayo, Peru. Illinois has a part-time observing site at Baker Lake, Canadian Northwest Territories. Stanford has a station at the University of Hawaii. The Bureau of Standards operated from its Central Radio Propagation Laboratory, Boulder, Colo. ⁂



*S-3 RADIATION SATELLITE is shown in NASA artist's conception.*

# Radiation Effects Are Little Known

## *Component testing for nuclear environments suffers from lack of standardization, limited experience*

by Richard van Osten

LOS ANGELES—Lack of standards for electronic components subject to nuclear environments drew major attention at the Winter Convention on Military Electronics of the Institute of Radio Engineers.

Several speakers made it apparent that while many technologies are moving rapidly toward nuclear fields, efforts to standardize test procedures for semiconductor devices have been only partially successful.

Dr. L. B. Gardner, Litton Systems, Inc., said procedures for such tests are being developed but probably will not be firmed up for a year or two. Much of the standardization work is being accomplished by various committees of the ASTM and AIEE. The test approaches to determine sensitivity of electronic components to radiation fields are, however, usually picked according to personal preference or availability.

This makes it difficult to relate results from one test to another in terms of flux densities and dosimeter measurements, which generally are not much greater than 45% to 50% of absolute accuracy.

Reports generated from such tests are also poor, according to A. B. Kaufman, Litton Systems, in that they do not define critical neutron spectrums and usually involve sampling cross-sections too numerically low to be valuable. Transistors are particularly sensitive, Kaufman pointed out; he noted that any given transistor type will vary from manufacturer to manufacturer and even units from the same manufacturer will vary in characteristics with different batches made at different times.

One problem here, Kaufman said, is that while many transistors may be well qualified electrically, they often exhibit poor nuclear characteristics that eliminate their use for certain applications.

• **More specifics urged** — Elimination of generic reports on such tests in favor of reports with more specifics would help, it was made clear. Both Gardner and Kaufman agreed that there are an almost infinite number of nuclear environments possible and that the military should be somewhat more specific in stating test requirements.

Kaufman suggested that the present test "standard" of 2.9 mev seems valid for semiconductor tests, but tests could be conducted at various density levels —$10^{12}$, $10^{14}$, $10^{15}$ and $10^{16}$ neutrons per square inch—to determine where satisfactory performance levels of each device might fall when exposed to a nuclear environment. This would provide basic component data to fit requirements of specific radiation environments and give researchers a "feel" for component selection.

Still another help for such programs would be a basic specification similar to the well-used MIL 5272 but covering nuclear requirements.

Contractors and researchers studying electronic component reaction to nuclear fields are up against a familiar problem. Dr. J. W. Clark, Hughes Aircraft Co., said there is no place at the moment for fundamentals in the work since all tests are to the letter of the contract in time, requirements and specifications.

• **Short on experience** — There is still little practical experience with nuclear or natural radiation fields other than in some areas of the Van Allen belt, Clark pointed out. Full-scale nuclear environments resulting from explosions or environments for electronic gear in nuclear missiles are difficult to simulate with reactor techniques. He urged also that work be pushed on radiation effects upon electron components in relation to component proximity to nuclear explosions.

A demand for such specific research is lacking, Clark said, adding that nothing is more depressing to a researcher or manufacturer than to develop something for which there is no demand. A good example of this, he said, are ceramic-type electronic devices which were developed principally because of their excellent high-temperature characterisitcs. Now the warehouses are full of them, Clark said; no one wants them.

Microcircuitry may hold the key to advanced electronic devices to operate in extreme radiation environments. Clark, Gardner and Kaufman agreed that the small size of such systems offers advantages in weight reduction for future space vehicles. In addition, shielding can be reduced by many factors, in turn reducing the very undesirable characteristic of a "step-up" transformer encountered with some shielding systems.

A whole new family of materials will grow with microcircuitry, the three experts agreed. Of special interest will be materials with low neutron absorption characeristics.

• **Traffic problem**—Satellite traffic in the future probably will run into the "low thousands," Ralph Deutsch and Richard B. Barrar of System Development Corp., told the meeting. The figure includes both "friendly" and "enemy" vehicles. With this amount of traffic expected, they said, it is necessary to develop some new technique now for determination of satellite trajectories because "we'll run out of computer capacity very fast with real time relationships."

Asked if a system similar to the SAGE (Semi-Automatic Ground Environment) computer could handle data required for future satellite traffic requirements, Deutsch said it was not likely, noting that the SAGE computer was "overloaded from the day it was designed."

**LOS ANGELES—Government-sponsored research and development programs in military electronics may be in for some sharp changes.**

**A Defense Dept. spokesman told the IRE winter meeting that changes in program handling are expected to bring about significant improvements. Dr. J. P. Ruina did not spell out the specifics of these changes but indicated some programs may be dropped in favor of new ones.**

**Dr. William Shockley, co-inventor of the transistor and head of Shockley Electronics, told the meeting a major problem with placing of goverment contracts was the "low technical competence of those holding the money belts." He recommended that salaries for DOD program management personnel be made competitive with industry. Dr. Shockley cited the Office of Naval Research as one of the military's best contract control agencies.**

# —contracts—

## NASA

8,505—**Space Technology Laboratories, Inc.**, Los Angeles, for studies to determine the most economical space vehicle for future payload requirements beyond *Saturn*.

0,125—**Douglas Aircraft Co. Inc.**, Santa Monica, Calif.,—same as above.

## AIR FORCE

2,000,000—**General Cable Corp.**, for control and communication cable for the first group of bases for the *Minuteman* missile.

2,000,000—**Aerojet-General Corp.**, Azusa, Calif., for additional research and development work on the *Midas* infrared sub-system. Subcontract from **Lockheed Missiles and Space Division.**

2,191,609—**Thiokol Chemical Corp., Redstone Div.**, for production of(M 60) solid-fuel rocket engines for the *Falcon* missile.

00,000—**Chance Vought Electronics Div.**, Dallas, for electronic test equipment for the *Titan* program.

50,000—**Defense Electronics, Inc.**, Rockville, Md., for state-of-the-art telemetry receiving equipment.

## NAVY

9,314,432—**General Dynamics Corp.'s Electric Boat Div.**, for drives and controls for the 600-foot "Big Dish" radio-telescope under construction at the Naval Radio Research Station at Sugar Grove, W.Va.

3,592,460—**Remington Rand Univac, Military Dept.**, St. Paul, for production of peripheral equipment for the Naval Tactical Data System and continuing work on the "software" phase of the program.

1,700,000—**Norris-Thermador Corp.**, Los Angeles, for *Polaris* A-2 first-stage rocket motor cases. Subcontract from **Aerojet-General Corp.**

985,000—**Giannini Controls Corp.**, Duarte, Calif., for counting accelerometers for installation in the fleet aircraft.

286,000—**Bulova Watch Co., Electronics Div.**, for frequency control devices for the command guidance of the *Bullpup* missile. Subcontract from **The Martin Co.**

72,649—**Republic Aviation Corp.**, Farmingdale, L.I., N.Y., for plastic radar reflectors to be used in conection with shipboard missile guidance systems. Subcontract from **Raytheon Co.**

## ARMY

,564,000—**Western Electric Co.**, for work to be performed on the *Nike-Hercules* missile system ($4,000,000 for production engineering services; $3,064,000 for research and development; $1,500,000 for the development of field manuals on the improved missile).

,900,000—**Sperry Utah Engineering Laboratory**, Salt Lake City, for continued work on the *Sergeant* weapon system.

,345,596—**Norris-Thermador Corp.**, Los Angeles, for warheads, rocket motor and body assemblies for 89,875 multiple rocket launchers.

400,000—**Sperry Utah Engineering Laboratories**, Salt Lake City, for production engineering services for the *Sergeant* system.

095,161—**Radio Corporation of America**, for work on an advanced radar to be used for in-flight study of ballistic missiles.

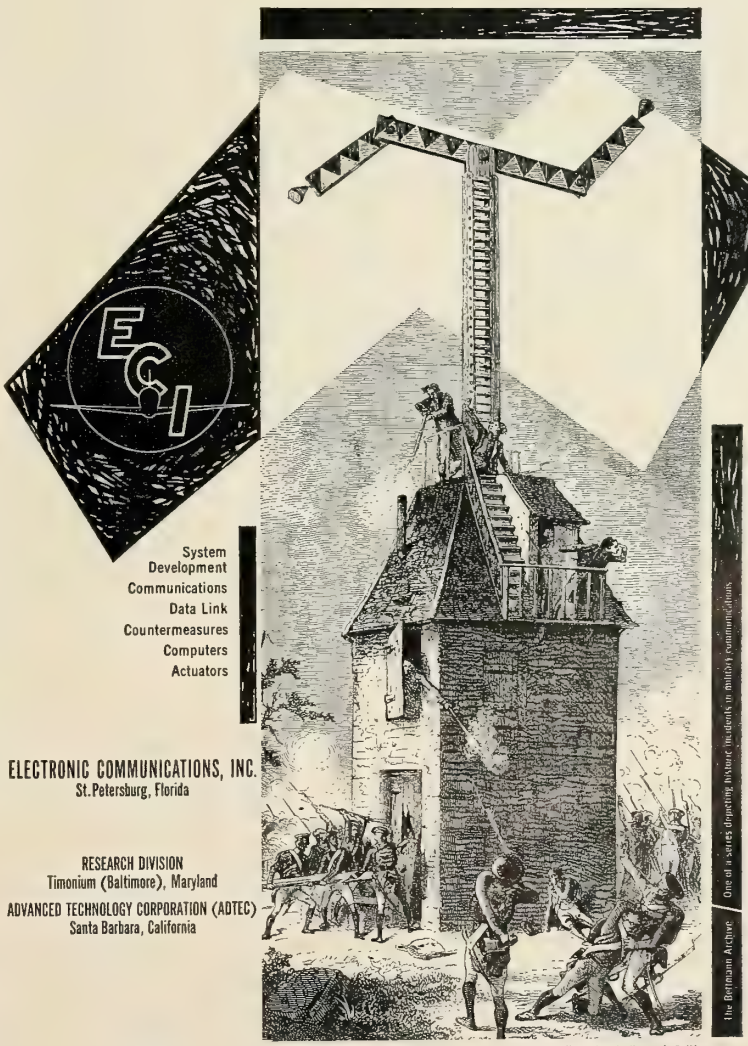
3,000—**Sperry Utah Engineering Laboratory**, Salt Lake City, for improved radar tracking-plotting system.

4,988—**ALCO Products, Inc.**, Schenectady, N.Y., for continued technical study of operation, testing and maintenance of three field nuclear power plants.


# LONG RANGE INPUT / 1794

News of the recapture of Condé from the Austrians was sped to the French Revolutionary Convention at Paris in a matter of minutes via Claude Chappe's amazing télégraphe aérienne, or relay aerial telegraph, Sept. 1, 1794. A new era in rapid communications had begun.

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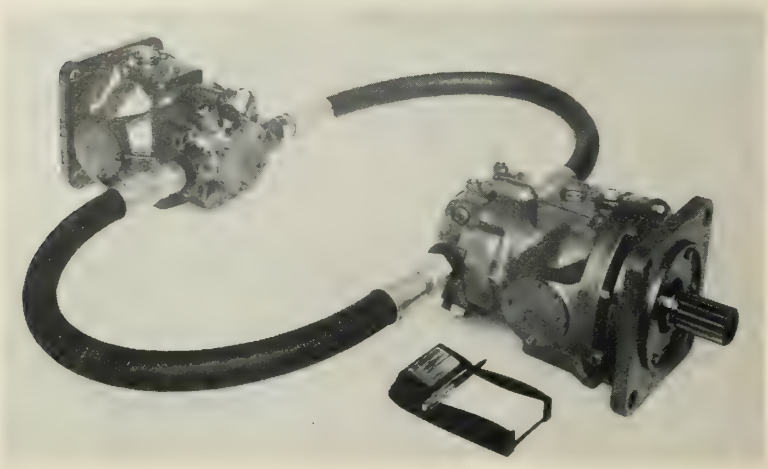

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### Hi Temp Gas Servo

A gas servomechanism, representing a technical state-of-art advance, is available from Weston Hydraulics, Ltd.

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### Thermoelectric Generators

Westinghouse Electric Corp. is prepared to design and manufacture a broad line of thermoelectric generators for commercial and industrial applications.

Four units, in ratings of 5, 10, 50 and 100 watts, are available and are typical of the range of devices that can be produced to orders.

The generators are completely static and are ideally suited for applications in remote locations. Depending on the application and the type of fuel used, the generators operate at core temperatures between 300 and 600°C. Typical units burning propane gas operate at 400°C.

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### Crimp-Type Contact

Elco Corp. is marketing a crimp-type contact, Varilok. Varilok will accept all wire sizes from numbers 18 gauge to 30 gauge. Varilok contacts are available loose, part number 8007.0313, with two sizes of hand-tools for crimping; and in reel form, part number 8007.0323, with power operated bench machine. Hand and power tools, plus a tool for inserting and withdrawal of contacts from connectors, are available.

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### Synchro Transmitter

Angler Industries have available line of synchro and resolver transmitters which feature front-panel mounting. A sub-miniature control dial allows the shaft of the synchro or resolver to be positioned with ¾° accuracy and 0.25° resolution. Zero may be set from the dial front without special tools (Operates at 60 or 400 CPS with input voltages to 115 volts.)

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### Sub-Miniature Accelerometer Marketed

A sub-miniature, non-pendulous constant-damped linear accelerometer weighing less than 3 oz. and slightly under 1 in.³ in volume is available from Minneapolis-Honeywell's Boston Div.

The instrument provides independent control of natural frequency for any given G-range. Control of the natural frequency is achieved through use of variable area fluid coupling.

The instrument operates at peak efficiency within a temperature range of −65° F. to +250° F. and will withstand shock up to 100 G's and vibration up to 2000 CPS at 30 G's.

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### Electronic Gaging Unit

An Electronic Gaging Unit, Electro-Probe, is available from Federal Products Corp.

Basic components are a small versatile gage head and light-weight, all transistor, battery operated amplifier meter. The Electro-Probe is normally powered by a mercury cell battery pack which provides over 1200 hours of continuous or intermittent operation. Optionally the user can power the unit with individual mercury cells or carbon cells or operate it from regular power lines.

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### Low Impedance Diode

An extremely low dynamic impedance 6.2-volt temperature-compensated zener diode is available from Motorola Semiconductor Products, Inc.

With the low dynamic impedance characteristic, the type IN821A diode minimizes voltage fluctuations due to changes in current. It has a maximum impedance of 10 ohms, and a typical value of 8 ohms.

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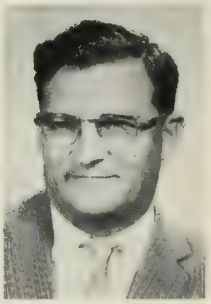
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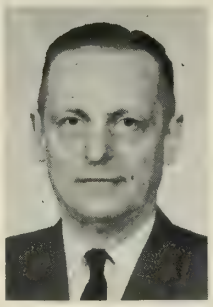
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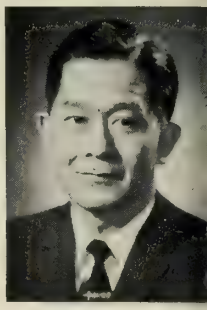
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**Charles Vanden Bulck:** Joins American Machine & Foundry Co.'s Government Products Group as manager of procurement. Was formerly assistant manager for administration of the U.S. Atomic Energy Commission's Oak Ridge Operations.

**H. Champman Rose** and **Chester A. Thompson:** Former chairman of the board and board member, respectively, of Jack and Heintz, elected to the board of directors of The Siegler Corp.

**William A. Rabe:** Appointed manager of the new Surface Radar and Electronic Warfare Development Laboratory in the Military Products Division of General Dynamics/Electronics. Prior to joining the firm, Rabe was manager of the Radar Receiver Engineering Laboratories of the Crosley Div. of the Avco Corp.

**G. Robert Jacob:** Former chief engineer for Measurements Research Co., joins Monitor Systems, Inc., a subsidiary of Epsco, Inc., as project manager.

**Samuel L. Sola:** Former assistant to the chief of Mechanical Systems Engineering at Nortronics Div. of Northrop Corp., joins the Ford Motor Co.'s Aeronutronic Div. as manager of automotive design for automotive electronic equipment operations.

**Dr. Shigeo Okubo:** Named manager of gyro platforms for the Precision Products Dept. of Nortronics. Prior to joining the firm he was engineering section head at Lear, Inc.

**Maj. Richard W. Brunson:** Replaces **Lt. Col. Paul J. Daigle** as senior representative of the Army Ballistic Missile Agency for the *Sergeant* program at Sperry Utah Engineering Laboratory.

**James H. Green, Jr.:** Appointed director of the Space Communications Division of the Alpha Corp., succeeding **Dr. J. E. Froehlich.** Green was formerly project director for Space Tracking and Communications.

**Dr. Herbert C. McKee:** Appointed assistant director of the Department of Chemistry and Chemical Engineering of Southwest Research Institute.

**Dr. Selby M. Skinner:** Former chief scientist to the deputy for research of the Air Research and Development Command of the Air Force, appointed manager of molecular electronics project at Westinghouse Electric Corp.'s Air Arm Division.

**Dr. E. J. Robb:** Former project engineer for the *Minuteman* inertial guidance system, appointed head of the System Analysis Section of Space Technology Laboratories, Inc.'s Inertial Guidance Dept.

**Charles E. Rees, Jr.:** Former project manager, named director of research for Actuation Research Corp.

**John L. Wilson:** Former manager of product development at Hercules Powder Co., named manager of Taylor Fibre Co.'s newly created division for production of filament-wound, reinforced plastic parts.

**Michael Newlon,** 17-year-old son of **Clarke Newlon,** Consultant for Military Affairs for AMERICAN AVIATION PUBLICATIONS, is among 40 national winners in the 20th annual Westinghouse Science Talent Search, chosen from more than 25,000 competitors.




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# —letters—

## Space Blood Pressure

*To the Editor:*

I enjoyed your article on *Sputnik V* (M/R, Jan. 23, p. 22) which carried the two dogs, 40 mice and other assorted living specimens. In it you mention that the Russians telemetered respiration, electrocardiograms, temperature and blood pressure from the dogs in flight. The article further states that no information was available on the method of measuring blood pressure. If the technique used in this flight was the same as used in previous ballistic and orbital flights (and it appears to be from reference to the exposed carotid artery) the technique employed is known as the oscillometric method of determining blood pressure.

In operation the vessel in which blood pressure is to be measured is surrounded by an inflatable cuff. To the cuff are connected two pressure indicators, one registering mean pressure and the other pulsatile (oscillometric) pressure only. The cuff is inflated to a pressure above suspected systolic and the oscillometer indicates only small pulsations. As the occluding cuff pressure is released, blood spurts through when the peak blood pressure (systolic) is greater than the occluding pressure. At this pressure, the oscillometer indicates larger pulsations. As the occluding pressure continues to fall, the magnitudes of the oscillations increase then decrease. The cuff pressure at which they decrease sharply is the minimum pressure (diastolic).

While the oscillometric method of measuring blood pressure is not as accurate as the auscultatory method used by all physicians, this latter method cannot be used in areas of high ambient noise. However the oscillometric method can indicate changes in blood pressure, probably the main interest of the Russian physiologists.

Although the oscillometric method of measuring blood pressure is not an invention of the Russians, it is interesting to note that the familiar method of measuring blood pressure, which is the technique employed routinely by all physicians, was invented in 1905 by a Russian named Korotkow.

L. A. Geddes, M.E., Ph.D.
Department of Physiology
Baylor University
College of Medicine
Texas Medical Center
Houston

## Waterloo Remet

*To the Editor:*

I cannot resist the temptation to query the historical accuracy of the interesting article (on Lt. Gen. Roscoe C. Wilson, AF Deputy Chief of Staff/Development) entitled "Scholarly Gentleman" (M/R, Dec. 5, 1960, p. 13).

I suggest a better historical allusion might have been to the tactics of GRANT at NORMANDY or, if desired to retain the British connection, to those of WELLINGTON at ALAMEIN.

Brigadier J. D. Adams, OBE
Trials Establishment Guided Weapons, Royal Artillery
Ty Croes Camp, Anglesey
N. Wales, U. K.

*In the Wilson profile, M/R referred to "the tactics of Marlborough at Waterloo." Our attention was drawn to this slip earlier (Letters, M/R, Jan. 2, p. 48).—Ed.*

# —when and where—

### FEBRUARY

**Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components,** (unclassified), **South Texas Section of the SNT and Southwest Research Institute,** Gunter Hotel, San Antonio, Feb. 14-16.

**Institute of Radio Engineers, International Solid-State Circuits Conference, 8th Annual Meeting, Sheraton Hotel and University of Pennsylvania,** Philadelphia, Feb. 15-17.

**American Society for Metals, Albuquerque and Los Alamos Chapters, Recent Developments in Materials for Nuclear Applications,** University of New Mexico, Albuquerque, Feb. 16-17.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting,** St. Louis, Feb. 19-23.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, Feb. 26-Mar. 1.

**Armed Forces Management Association, Annual National Conference,** Shoreham Hotel, Washington, D.C., Feb. 28-Mar. 2.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

### MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.

**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

**Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, PCNS, AIEE, IAS,** University Museum, Philadelphia, Mar. 9-10.

**Institute of the Aeronautical Sciences, Flight Propulsion Meeting,** (classified), Cleveland, Mar. 9-10.

**American Rocket Society, Test Operations and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

**American Society of Mechanical Engineers, Aviation Conference,** Statler Hotel, Buffalo, N.Y., Mar. 13-17.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

**Fifth National Conference on Aviation/Space Education,** Mayflower Hotel, Washington, D.C., Mar. 16-18.

**American Congress on Surveying and Mapping, and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 19-25.

**IRE International Convention,** Coliseum and Waldorf-Astoria Hotel, New York, Mar. 20-23.

**Nuclear Congress, Nuclear Engineering and Science Conference sponsored by 30 major engineering societies and Engineers Joint Council,** Chicago, Mar. 20-24.

**American Society for Metals, 12th Western Metal Congress,** Ambassador Hotel, and **Western Metal Exposition** in Pan-Pacific Auditorium, Los Angeles, Mar. 20-24.

**23rd Annual American Power Conference, Illinois Institute of Technology, 9 technical societies and 14 universities,** Sherman Hotel, Chicago, Mar. 21-23.

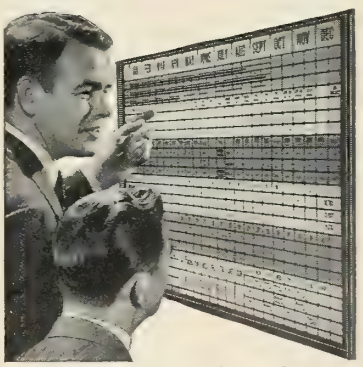
**American Chemical Society,** National Meeting, St. Louis, Mar. 21-30.

**4th Symposium on Temperature, Its measurement and control in Science and Industry, sponsored by ISA, American Institute of Physics, National Bureau of Standards,** Veteran's Memorial Hall and Deshler Hilton Hotel, Columbus, Ohio, Mar. 27-31.

**American Nuclear Society, Nucleonics in Flight Symposium,** Statler Hilton Hotel, Dallas, Mar. 28-29.

**23rd Annual American Power Conference,** Sherman Hotel, Chicago, Mar. 21-23.


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## reviews

AN ION ROCKET WITH AN ELECTRON-BOMBARDMENT ION-SOURCE. Harold R. Kaufman. Order NASA Technical note D-585 from National Aeronautics and Space Administration, Washington 25, D.C. 38 pp., $1.

An ion-rocket engine with a 10 cm-diameter electron-bombardment ion source was investigated. Both theory and experimental results are presented in the report, which concludes that an electron-bombardment ion-source appears to be one of the most promising for ion rockets.

A STUDY OF THE POSITIONS AND VELOCITIES OF A SPACE STATION AND A FERRY VEHICLE DURING RENDEZVOUS AND RETURN. John M. Eggleston and Harold D. Beck. Order NASA Technical Report R-87 from National Aeronautics and Space Administration, Washington 25, D.C.

A study of the families of nonthrusting ascent trajectories during rendezvous with an orbiting space station and descent trajectories to the earth's atmosphere. Equations of motion are derived and results are shown for two typical orbits of the station (one circular and one elliptical orbit). Boundaries of launch (at time of booster burnout) and rendezvous conditions are given and the effects of delays in launch time are discussed.


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Aerojet-General Corp., Sub.-Gen. Tire & Rubber Co. . . 52
Agency—D'Arcy Adv. Co.

Amcel Propulsion, Inc., Sub. Celanese Corp. of America . . . . . 18, 19
Agency—Ellington & Co., Inc.

Boeing Airplane Co. . . . . 10
Agency—Jones & Hanger, Inc.

Clary Corp. . . . . 6, 7
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Commonwealth of Pennsylvania, Dept. of Commerce . . . 8
Agency—Bachman, Kelly & Trautman, Inc.

Consolidated Electrodynamics Corp. . . . . 36, 37
Agency—Hixson & Jorgensen, Inc.

Electronic Communications, Inc. . . . . 43
Agency—Alfred L. Lino & Assoc.

Engelhard Industries, Inc. . . . . 46
Agency—Stuart Sande, Adv.

Graphic Systems . . . . . 47
Agency—Caswell Adv. Agency

Hallicrafters Co., The . . . . . 4
Agency—Henry B. Kreer & Co., Inc.

Hughes Aircraft Co. . . . . 51
Agency—Foote, Cone & Belding

Kearfott Co., Sub.-General Precision Equipment Corp. . 39
Agency—Gaynor & Ducas, Inc.

Leach Corp. . . . . 2
Agency—Hixson & Jorgensen, Inc., Adv.

Northrop Corp. . . . . 20, 21
Agency—Doyle, Dane, Bernbach, Inc.

Radio Corp. of America, Industrial Electronic Products . . 32, 33
Agency—Al Paul Lefton Co., Inc.

Rocketdyne, a Div. of North American Aviation, Inc. . . 26, 27
Agency—Batten, Barton, Durstine & Osborn, Inc.

Space & Information Systems Div. of North American Aviation . . . . . 9
Agency—Batten, Barton, Durstine & Osborn, Inc.

Thiokol Chemical Corp., Rocket Div. . . . . 3
Agency—Hicks & Greist, Inc.

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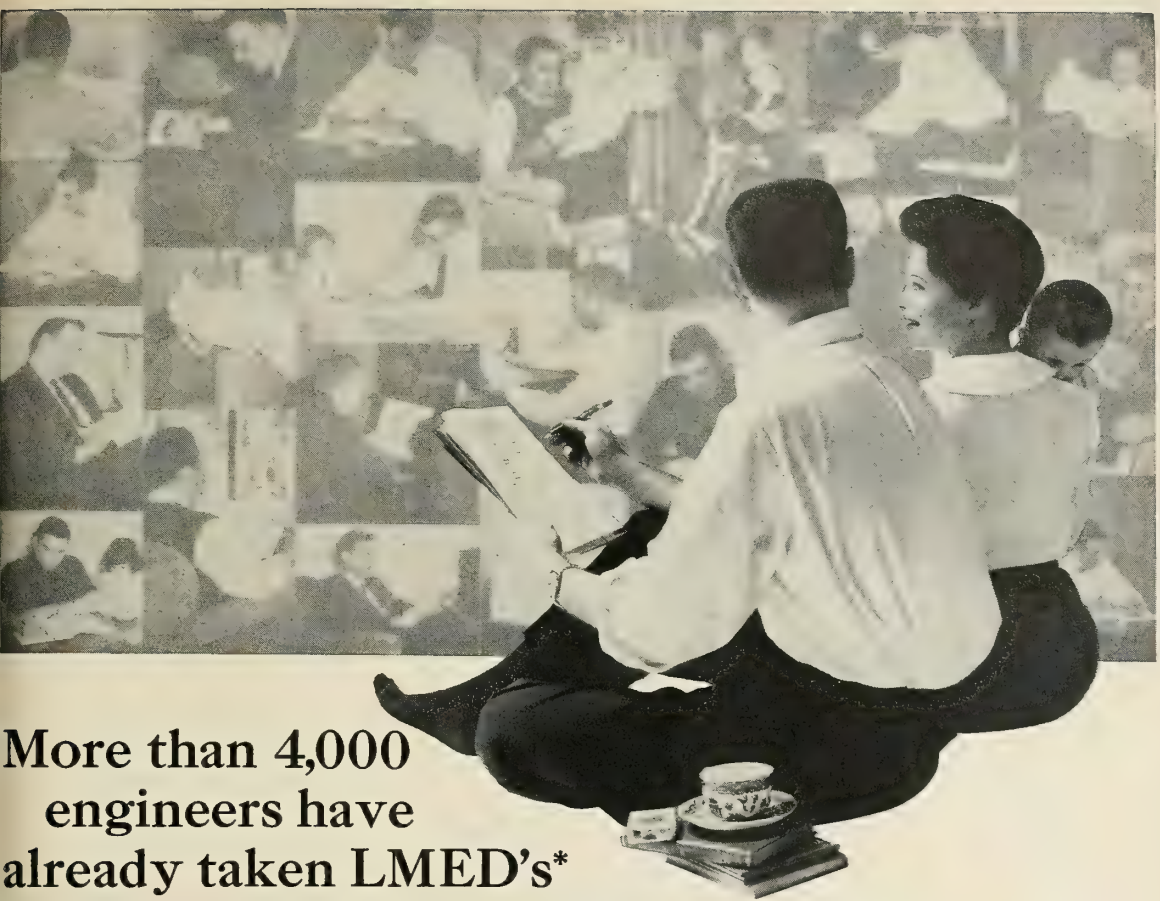
Experiment, Inc. . . . . 48
Agency—Eastern Adv., Inc.

General Electric Co., Light Military Electronics Dept. . . 49
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## editorial . . .

# A Tempest In A Samovar

THE APPEARANCE of Soviet Gen. Mikhail N. Kostiuk and an aide at the American Rocket Society's conference on solid propellants at Salt Lake City touched off one of the most disgraceful, juvenile incidents we have encountered.

It certainly reflected no credit on the industry.

This is what happened: Gen. Kostiuk, air attaché at the Soviet embassy in Washington, was granted permission to attend the ARS conference. At a cocktail party on the opening night, Gen. Kostiuk was conversing with Associate Editor Frank McGuire of our West Coast staff. A photographer for Thiokol Chemical Corp. asked permission to take their picture and promised Mr. McGuire a print.

Mr. McGuire and the general agreed to be photographed—the latter somewhat reluctantly.

Later that evening, our associate editor was stopped in the hall by a Thiokol executive who told him: "Say, McGuire . . . We've been told by CIA that they don't think you should have that picture so we'll have to keep it." Mr. McGuire's request to talk to the CIA agents was turned down by the Thiokol official.

Remember, this was a photograph taken at an open cocktail party in a public hotel. It was taken at Thiokol's request with a promise Mr. McGuire could have a copy if he desired. It involved no government employees, no government facilities, no government equipment and no government information.

Mr. McGuire describes his reaction this way: "Until that statement I had no more than a passing interest in the picture; then the sheer brass of the people involved got under my journalistic skin."

Next morning, a Thiokol public relations man informed Mr. McGuire the FBI also had told the company to withhold the picture. Later, another Thiokol public relations man told him: "(An official) of the American Rocket Society is afraid you'll make a big story out of the Russians' presence, so he and (the Thiokol official) decided not to give you the picture so you couldn't print it."

At this point, ARS public relations manager Rod Hohl stepped in. Mr. Hohl had the good sense to realize what was happening and soon reported ARS objections to release of the photo had been lifted.

The photograph still was not forthcoming from Thiokol, however, as Mr. McGuire was referred to at least five different persons, each of whom disclaimed any knowledge of the whereabouts of the film.

Finally, at 1:50 p.m., Mr. McGuire told a Thiokol public relations man: "Harold Ritchey, Thiokol vice president and president of the American Rocket Society, is giving a press conference at two o'clock. That is ten minutes from now. If I don't have that picture, I will ask him before the television cameras and radio microphones why the photograph of a Russian general attending his technical meeting is so hard to obtain. I suspect he'll have a good answer, since he very likely hasn't the slightest idea what has been going on."

Within 10 minutes, Mr. McGuire received six copies of the picture.

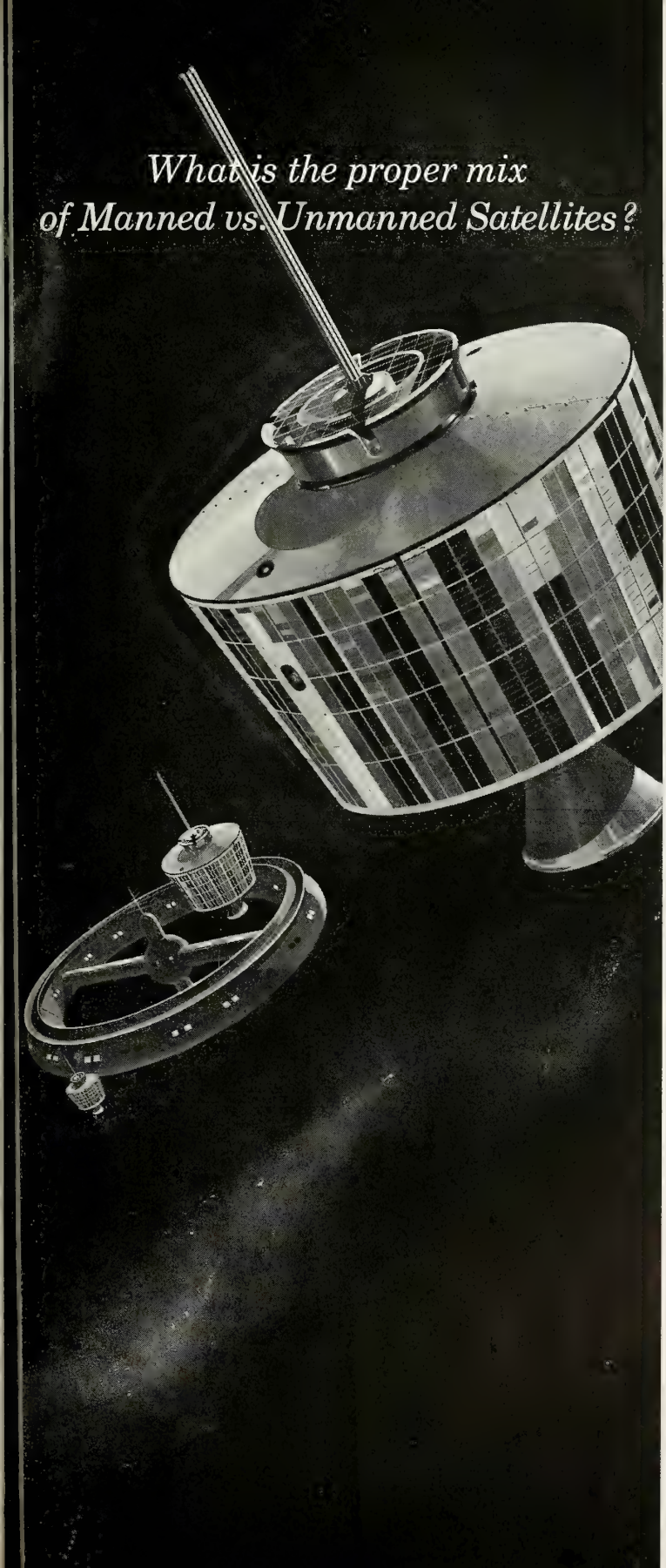
Were CIA and FBI agents really involved? We don't know. Thiokol representatives later blamed ARS for the whole affair and ARS blamed Thiokol. The incident was no credit to either one.

WE ARE INVOLVED in a serious military and economic competition with the Russians, and it is about time we grew up in our attitude toward them. Did those people really expect to sneak a Soviet general into and out of an ARS meeting without the press becoming aware of it? Their ham-handed handling of the incident resulted in just the effect they were trying to avoid, a distraction from the technical importance of the meeting.

Gen. Kostiuk's conduct was quite proper. But the individuals involved from the missile/space industry acted like panicky schoolboys. Until we can be a little more adult about the presence of Russian officials at a meeting, perhaps it is best they not be permitted to attend.

We also would like to ask one more question. When was the last time the U.S. air attaché in Moscow was allowed to attend a Soviet meeting on rocket propulsion in a sensitive missile center 2000 miles from the Russian capital?

**William J. Coughlin**




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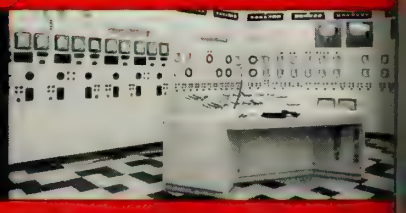
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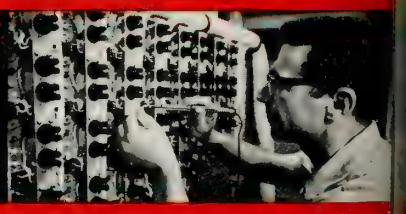
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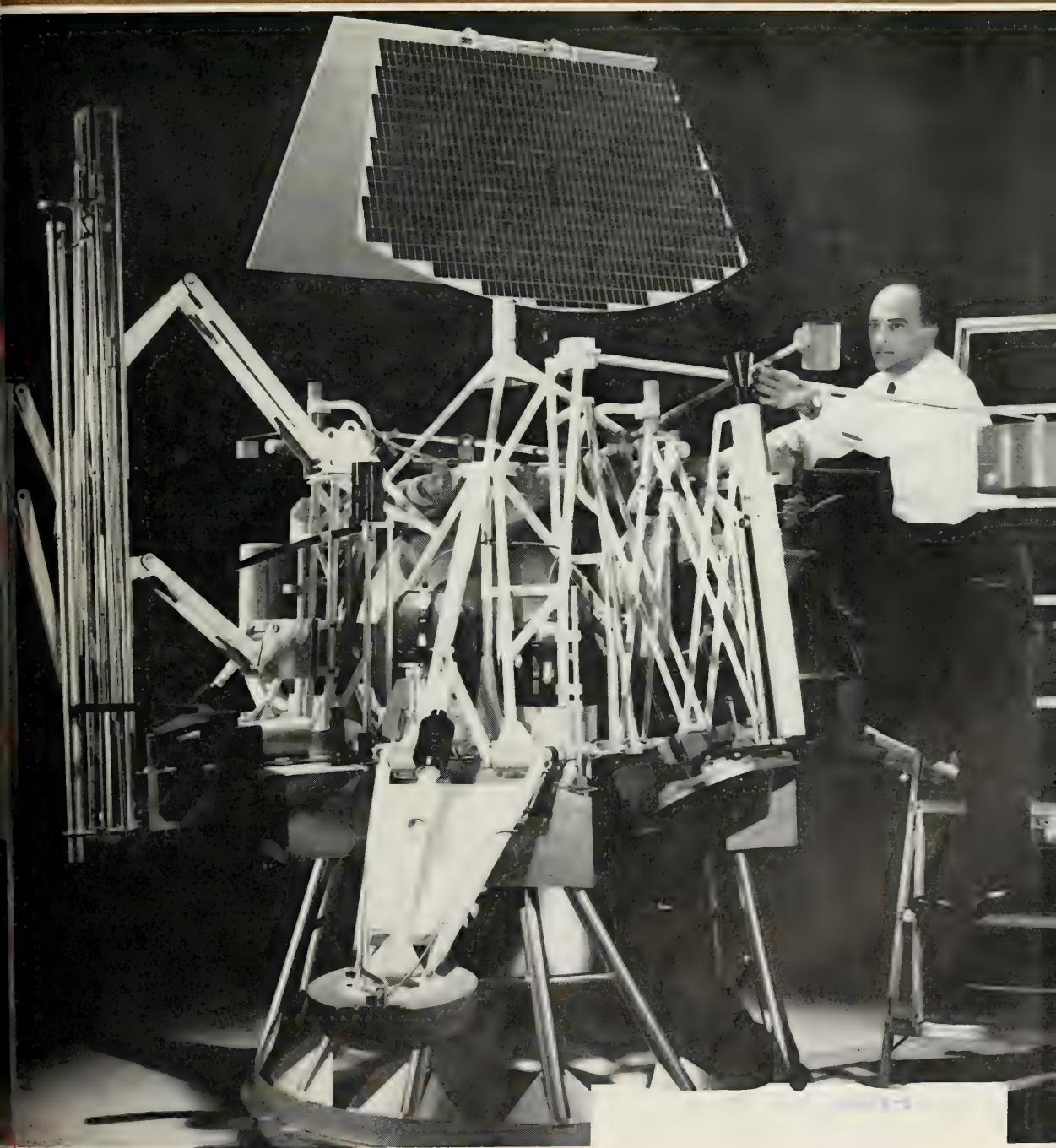
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FEBRUARY 20, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

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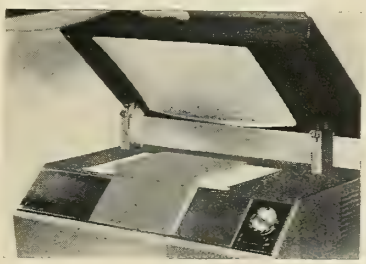
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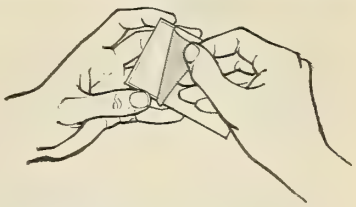
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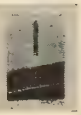
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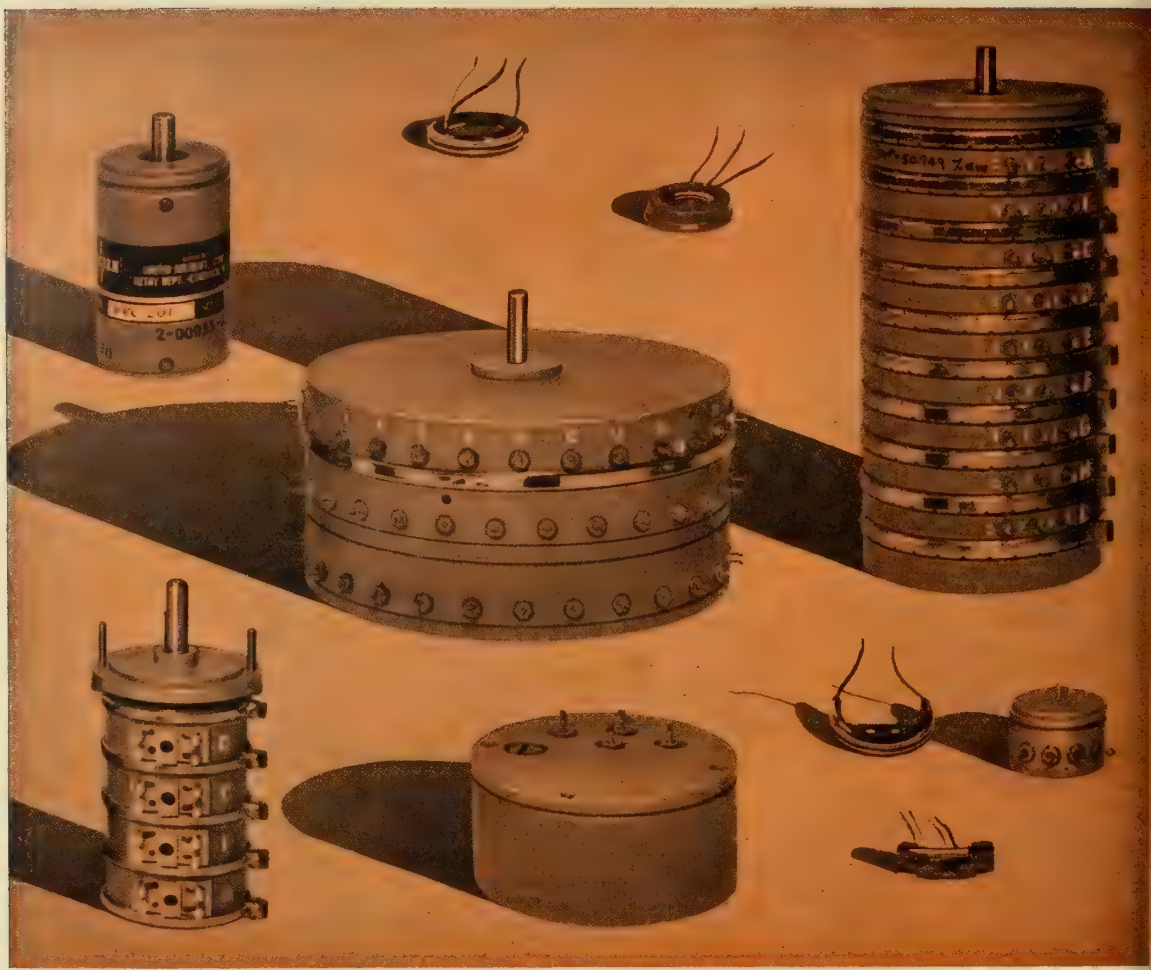
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THE MISSILE SPACE WEEKLY

missiles and rockets

Volume 8, No. 8 February 20, 1961

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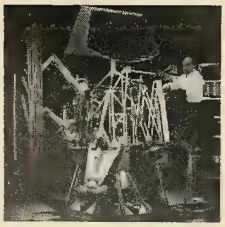
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## THE COVER

*Full-scale model of Surveyor spacecraft's payload is checked by Dr. Leo Stoolman, of Hughes Aircraft Co., which will build seven of the vehicles for NASA.* *See p. 40.*

## FEBRUARY 20 HEADLINES

### SIGNIFICANCE OF SOVIET VENUS PROBE

Red Military Space Threat Materializes ..... 13
Man May Gain First Real Knowledge of Venus .. 14
U.S. Reschedules Venus Shot for August, '62 .... 15
Experts Believe Probe Was Sputnik Backup .... 16
Means Examined for Speeding U.S. Boosters .... 16

'Beanstalk' to Provide Emergency Signals for SAC ... 17
NASA Has Intramural Competition for Next Explorer . 25
Titan Program Jumps Ahead with 5000-mile Success . 27
Weight of Surveyor Payload Will be Doubled ..... 40

## ADVANCED MATERIALS

Switch to Titanium Will Slash Minuteman Weight ... 22

## SPACE SYSTEMS

Re-entry Heat Simulated by Lockheed Hydrogen Jets 24
Cook Proposes Magnetic Field to Slow Re-entry .... 26

## SPACE MEDICINE

NERV Data Revises Plans for Shielding on Probes .. 28
NASA Experts Fear Soviets May Contaminate Venus . 30

## GROUND SUPPORT

Canaveral Scheduling Is Tribute to Cooperation .... 32
Huge Atlas-Centaur Launch Complex Near Completion 34

## ELECTRONICS

Bell Labs Advance Superconducting Solenoids ..... 35

## INTERNATIONAL

European Space Club Considers 92-ft. Rocket ..... 36
Two French Firms Move into Ballistic Missiles ..... 38

## DEPARTMENTS

The Missile/Space Week† ..... 6
The Countdown ..... 9
Industry ..... 18
Technical Countdown . 21
Soviet Affairs ..... 39
Contracts ..... 43
Reviews ..... 43
Names in the News .. 44
Products & Processes . 45
When and Where .... 48
Editorial ..... 50

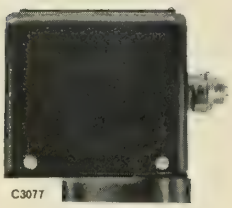
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# The Missile/Space Week

## Reds Welcome Cooperation

Soviet Premier Khrushchev, flush with the success of the Russian Venus probe launchings, welcomed President Kennedy's offer to pool space projects.

Khrushchev made the statement in thanking Kennedy for his congratulations on the launching of the Venus Rocket. Khrushchev also called for disarmanent.

## Probe ICBM Base Lag

Congress began focusing a sharp eye on missile base construction slippage last week.

House Appropriations Subcommittee heard defense contractors blame constantly shifting Air Force specifications. Industry representatives were reported to have said that such practice had doubled or even tripled costs in the multi-billion-dollar program. Air Force and Army officials will testify next in the closed sessions.

Meanwhile, union leaders attacked the problem of wildcat strikes. Confidence reigned that AFL-CIO would call for a no-strike policy concerning missile bases.

## Russell Likes Nike-Zeus

Committing *Nike-Zeus* to production apparently has the support of Senate Armed Services Committee Chairman Richard Russell (D-Ga.). After observing tests at White Sands Missile Range he said he feels much better about the program and "obviously appropriations have not been enough." Status of the AICBM is undergoing appraisal by the House Space Committee.

Meanwhile, joint U.S.-Canadian talks are underway on missile defense techniques, particularly on future *Nike-Zeus* deployment against unfriendly ICBM's.

Earlier this month, Air Materiel Command Chief, Gen. S. E. Anderson said that in addition to a nuclear-powered aircraft striking force, the U.S. should have planes equipped with air-launched anti-ICBM missiles.

## GE to Study Fluid Metals

General Electric's Flight Propulsion Laboratory Department in Cincinnati will make an 18-month study of heat transfer characteristics of liquid metals as working fluids for nuclear electric power systems for spacecraft.

GE will share costs—estimated at $575,000—with the National Aeronautics and Space Administration. Exact terms remain to be negotiated.

## X-15 Progress Report

The *X-15* rocket aircraft has neared its first flight with the super engine.

North American Aviation Feb. 10 turned over to NASA the No. 2 aircraft with its 57,000-lb.-thrust XLR-99 engine.

Only three days before the No. 1 aircraft with two 16,000-lb.-thrust XLR-11's set a world speed record of 2275 mph. It will be returned to North American for fitting with an XLR-99 and uprating.

With the big engine, the *X-15* is expected to reach altitudes approaching 100 miles and speeds approaching 4000 mph.



**Titan Engine Skirt**

*ABLATIVE SKIRT on Aerojet second stage engine thrust chamber allows "Dry jacket" altitude start. Design precludes contamination of engine compartment by fuel leakage during first-stage operation.*




WEST COAST NEWS EDITOR Bill Wilks talks with Air Force officer at Edwards AFB, Calif., in course of covering test of North American's X-15 rocket plane.

# memo from the publisher

GOOD MISSILE/SPACE industry reporters are almost as hard to find these days as a two-headed bionicist. But we've found another one, and he joins our West Coast staff this week as news editor.

Bill Wilks comes to us from the Los Angeles bureau of United Press International, where he's been covering the industry as Aviation/Space editor.

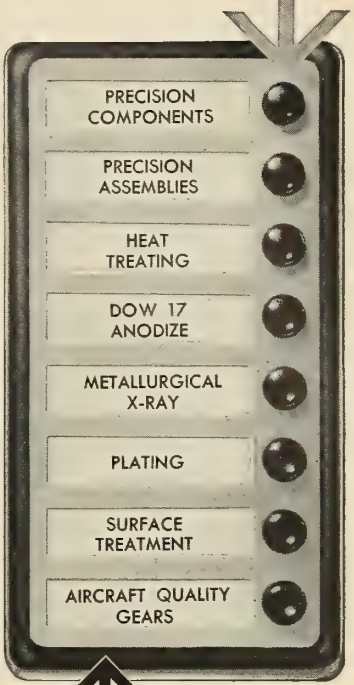
Bill, a 10-year veteran with UPI, covered more of the early missile shoots at Vandenberg Air Force Base than any other newsman. In September, 1959, his work won him a Columbia University science-writing fellowship under the auspices of the Sloan and Rockefeller Foundations. His tour of duty at Columbia not only improved his background in the basic sciences, but enabled him to visit almost every major missile/-space installation in the country, including such science centers as Brookhaven Laboratory and the Massachusetts Institute of Technology. An Air Force navigator during World War II, Wilks worked as a newspaper reporter and radio newscaster before joining UPI. He's married, lives in Glendale, Calif., with his wife and two small Wilkses. Bill is a member of the American Rocket Society and the Aviation/Space Writers Association. His major outside interest at the moment is in filling a publisher's request for an introductory book on space.

* * *

M/R's SPECIAL REPORT on *Nike-Zeus*, published three weeks ago, has caused quite a stir in industry, military and congressional circles. Perhaps the most significant development occurred on the floor of the Senate on Thursday, Feb. 2, when Sen. Strom Thurmond (D-S.C.) stood up and urged immediate production of *Zeus*. During the course of his speech, he called attention to and placed in the Congressional Record the article "Nike-Zeus Now?" and the editorial "The Nike-Zeus Team" from the Jan. 30 issue of MISSILES AND ROCKETS. And 35 copies of the issue were sent over to the House Space Committee as background reading for their Feb. 15 appraisal of *Zeus*. We like this kind of reaction and we're sure you do, too.

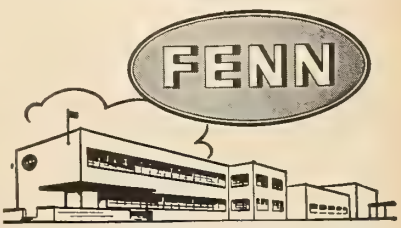
Edmund C. Bickfeld

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# The Countdown

## WASHINGTON

### Measuring the Missile Gap

Intelligence estimates of the number of Soviet ICBM's now operational are understood to range from about 35 to about 150 depending on what and whose criteria is used. Among other items that must be kept in mind in figuring-your-own Missile Gap is the number of 200-to-300-mile range missiles now deployed aboard conventional Soviet submarines. Also there is the margin of error factor: How thin do you want to slice it?

### Storable Atlas Dropped

Plans for a storable *Atlas* have been quietly dropped by the Air Force. Reasons: Advent of the storable *Titan* and success in flight-testing *Minuteman*.

### Talking to Polaris in the Pacific

The Navy is expected to use two powerful VLF communications centers to link planned squadrons of *Polaris* submarines in the Pacific to the nation's strategic alert system. One center is already in operation at Gym Creek, Washington. The other is expected to be built in Australia where sites are now being surveyed.

### Air Force Reviewing Missile Management

A high-level study group is understood to have been set up by the Air Force to take a thorough look at present management of R&D for strategic missile programs. The review is in line with criticism by the Kennedy Administration of present operations.

### Titan Deployment Schedule Holds Firm

Latest reports from the sprawling *Titan* program show that despite past hitches the first *Titan* squadron is still expected to be operational the middle of this year. The first two of 14 *Titan* squadrons are at Lowry AFB near Denver.

### Manned Rocket Flight Decision Due

Decision on whether a man will be in the next *Redstone*-boosted *Mercury* flight down the Atlantic Missile Range is scheduled to be made possibly late this month. It will be based on final data from the recent flight of Ham, the chimpanzee. The two biggest problems with Ham's flight: Excessive thrust and loss of the capsule's heatshield. Neither appears to be major.

### Atlas-Mercury Fix Readied

Engineers are preparing to make the needed fix on the interstage area between the *Atlas* and *Mercury* capsule for the *Mercury-Atlas* 2 launching later this month. The exact nature of the fix will probably not be finally decided on until shortly before the launching.

## INDUSTRY

### Bullpups: Cheaper by Two?

The Navy says it is going to second-source the Martin *Bullpup* to "expand our mobilization base and permit us to enjoy the fruits of competition." The move catches Martin in the midst of a cost-cutting drive to bring the price of the air-to-surface bird below $3000 (COUNTDOWN Jan. 30). Thirty-six companies are in the bidding for the second contract, to be awarded at the end of next month. A second source will make both HE and nuclear-tipped *Bullpups* for the Air Force as well as the Navy. Martin will continue to make both models, but its output may be curtailed.

### Whither Aerospace Corp.?

Officials of Aerospace Corp. are letting it be known that they are virtually marking time until the Kennedy Administration makes some hard decision on future U.S. space activities. Right now about 20 programs are in some phase of activity by the Air Force's non-profit firm. A big AF space program presumably could bring about a three-fold increase in the 400 technical personnel at Aerospace.

### Impacting a Launch Car

Engineers are still trying to decide how to install the *Minuteman* R&D railroad launch car at Cape Canaveral —where there is no railroad. They may be forced to bring it to the Cape by barge, dismantle it, truck it to launch complex, and reassemble the car on a short stretch of track adjacent to the pad.

### The Computer Remembered

Someone forgot to program into the computer the fact that a *Minuteman* scheduled for launch Jan. 31 was an R&D model without a warhead. This is why the shot, which did go two days later, aborted within seconds of liftoff.

### New Ion Thruster

Rocketdyne Division of North American Aviation has developed a novel ion thrust device which depends upon a large surface ion source. No details except, to make it work the electrodes must be "in the right order in the right geometry."

## INTERNATIONAL

### Venus or Bust

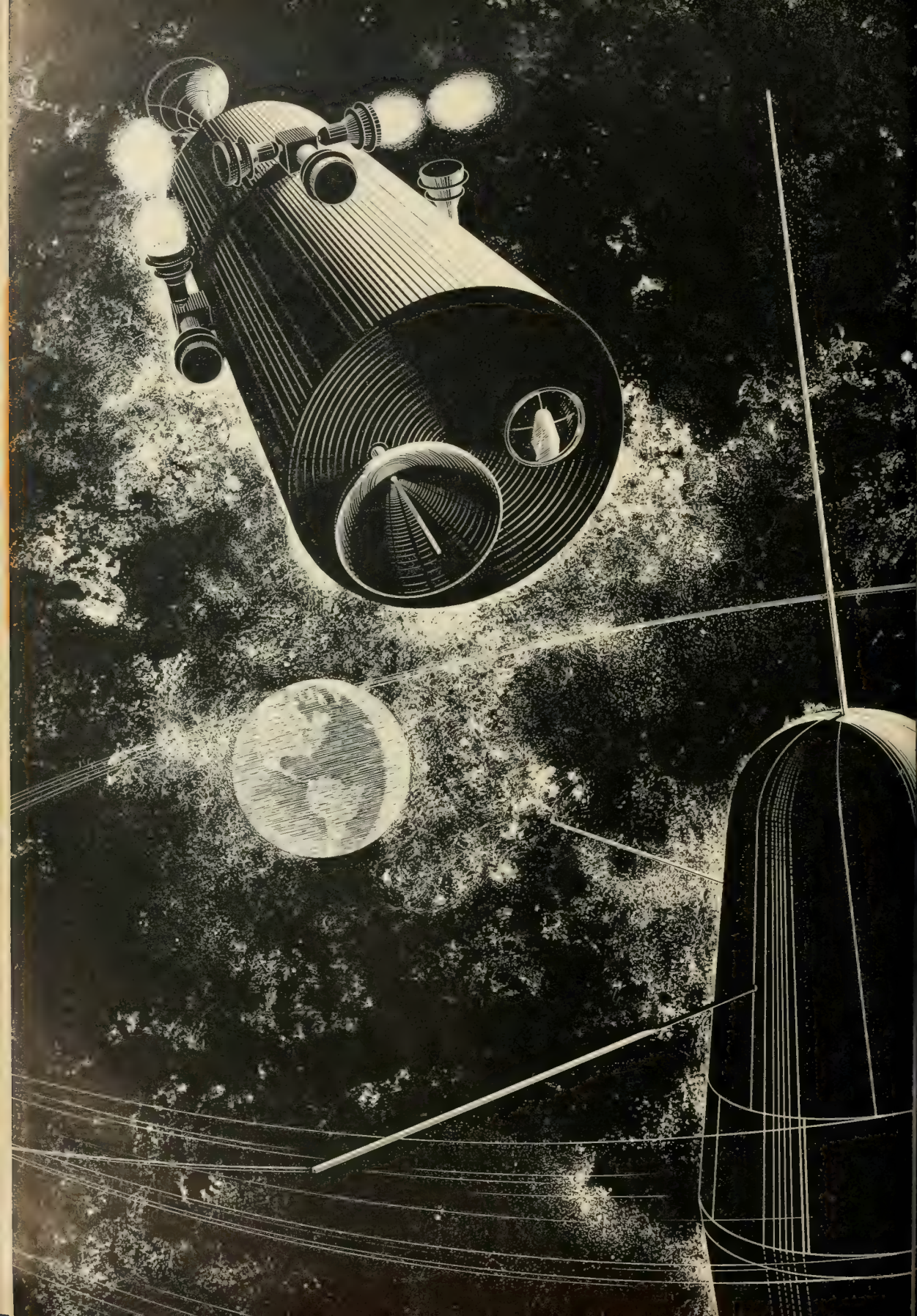
Sudden shift in the estimated time of arrival of the Soviet spacecraft at Venus (from mid-May to April) is being explained by U.S. scientists as meaning the vehicles was off course, originally. The Russians realized the probe would miss at the longer intercept point (see p. 14) so they tried for an earlier one by firing retros and attitude control rockets that had been intended to make the space craft orbit Venus. This means, perhaps, the best the Soviets can now hope for is a near-miss of the planet.

### Overseas Pipeline

Japanese military intelligence sources believe Russia gave Red China the nuclear device they are getting ready to fire this year (COUNTDOWN Jan. 30) . . . France's SEPR rocket development organization has signed a technical assistance agreement with Royal Dutch Powder Establishment and the Dutch National Consortium Inrichtingen . . . Space vehicle being eyed by the proposed European "Space Club" would be as big as a *Titan* ICBM (see p. 36).



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# SPACE RENDEZVOUS

## New PAT-C Applications Demonstrate Marquardt's Capability in Precision Controls

Typical of Marquardt's Control Systems capable of meeting the sophisticated requirements of today's weapon and scientific vehicles is the Corporation's Position-Attitude-Trajectory Control System.

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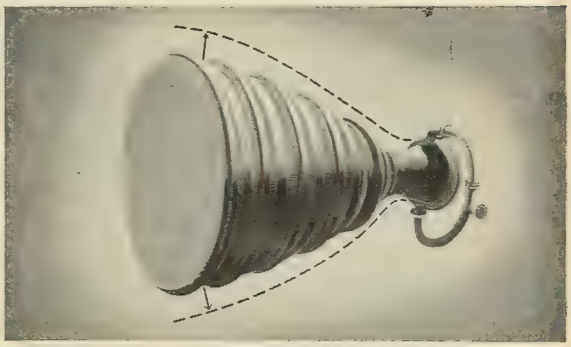
PAT-C is a highly responsive jet reaction system which controls the Position, Attitude and Trajectory of space vehicles as a result of inputs from the vehicle guidance system or ground control signals. The system provides the extremely precise corrective action based on simple position and velocity error signals, or will respond to the demand of guidance computers in the system. Tests demonstrating the flexibility of the PAT-C system range from multiple restarts up to 200 times per second to four minutes of continuous operation on a radiation cooled thrust chamber and nozzle.

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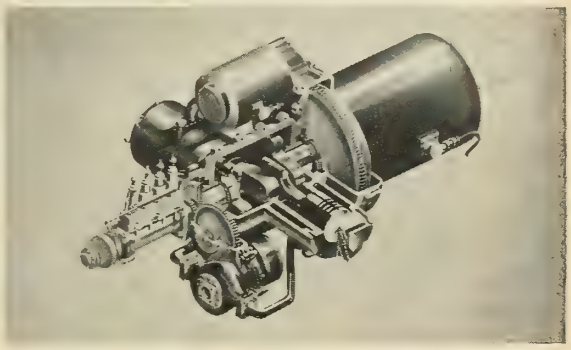
For example, products demonstrating the company's diversified capability include: gas operated servo systems for thrust vector control of an advanced ballistic missile; inlet controls for the McDonnell F4H-1 and the North American Hound Dog (GAM 77); a radically new space power unit; and control systems for the Bomarc ramjet engine and the Project Pluto nuclear ramjet engine.

For additional information concerning the PAT-C system or other controls capabilities contact Dick Oblinger, Chief Application Engineer, Controls and Accessories Division.

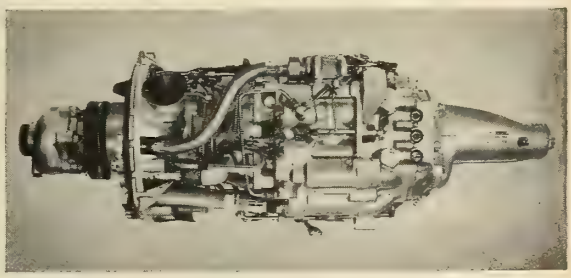
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**SHOOTING VENUS**

# Military Space Threat Grows

***Big Soviet spacecraft increases fears U.S. may be outflanked in space strategically. Future Red vehicles could be manned, carrying missiles to suppress American defenses. Kennedy recognizes 'secondary' position in rocket boosters; asserts space must be prevented from becoming brand 'new area of war'***

**by James Baar**

A SOVIET SPACECRAFT whizzing toward Venus increased military fears this week that Russia will try to outflank the United States by deploying bombers and missile-launching satellites in space.

Moreover, a number of military planners saw the Venus rocket feat as a major step toward building spacecraft capable of neutralizing U.S. surveillance, early-warning and communications satellites now under development.

This was the major military significance seen in the "peaceful" launching Feb. 12 of the 1419-lb. Venus probe from an orbiting Soviet satellite.

An immediate result was to put new urgency behind Air Force proposals for the rapid development of a family of offensive and defensive space systems—manned and unmanned.

President Kennedy told a news conference three days after the Venus rocket launching that Soviet superiority in boosters was a "matter of great concern." He said that "unless we are able to make a breakthrough before *Saturn*, then we have to recognize we are in a secondary position in boosters."

"It is going to be a major task to surpass them," he said without elaborating on his plans for the space program.

Kennedy made no allusion to the military significance of the Venus rocket. He said only that "preventing outer space from being used as a new area of war" is of the greatest concern.

• **Air Force arguments**—Plans for a family of military offensive and defensive space systems have been under study by the Air Force for some time and have been presented in detail to the Kennedy Administration. Considerably greater impetus for many of these proposals is expected in a forthcoming report being prepared by a special military space study committee set up by Lt. Gen. Bernard Schriever, commander of ARDC.

The committee is headed by Trevor Gardner, former assistant to the Secretary of the Air Force for R&D. It includes Dr. Jerome Wiesner, Presidential Science Adviser, as well as a number of other noted scientists and engineers.

Air Force officers have argued repeatedly that the United States must be prepared to meet a Soviet military threat in space.

Most military planners consider the use of missile-launching satellites the expensive way to deploy a strategic striking force. However, some argue that the capability to launch orbital space bombers or missile-launching satellites could, at a time when both Russia and the United States possess large numbers of missiles, tip the balance of power.

Lt. Gen. Roscoe C. Wilson, Air Force Deputy Chief of Staff/Devolpment, recently put it even more strongly. (M/R, Dec. 12, 1960):

"The essence of military supremacy is access. The only thing that has kept Russia under control is our supremacy in the air. The air alone did this until the missile came along and the missile won't last forever. The means of access to Russia will be aerospace. Whoever dominates space is going to dominate the earth."

• **Defenses lacking**—In accordance with this line of military thinking, Lt. Gen. Laurence S. Kuter, commander of the North American Air Defense Command, is understood to be preparing a request to the Joint Chiefs of Staff calling for defense systems capable of combatting a broad range of space weapons.

Kuter's command only last month took charge of the Navy's silent satellite detection network. Two days after the Venus rocket was launched the general said NORAD wants to be able to make a "millisecond check" of any unidentified objects in space.

However, the United States at present has no operational weapon that could be used to destroy or neutralize an enemy satellite or spacecraft. Nor does the United States have any means of determining whether a satellite is a threat to the nation's security.

Both military and civilian experts agree that the Soviet satellite from which the Venus rocket was launched could just as easily launch nuclear-tipped missiles at the United States with great accuracy.

They also agree that the booster that placed the launching satellite into orbit could just as well have launched a *Dyna-Soar* type space bomber carrying men and nuclear weapons. Dr. Eugen Saenger, father of the *Dyna-Soar* concept, said such a Soviet spacecraft could have carried two or three men.

However, congress in general continued to await the Administration's lead on how it would proceed in the long-expected shake up of the nation's space programs.

As these programs stand today:

–The Pentagon has under development only two weapons that might conceivably be useful against satellites or spacecraft. The two: *Nike-Zeus* and *Sky Bolt*. The *Dyna-Soar* project is a slow-paced research program. *Saint*, a satellite inspection system, and other advanced space weapon projects are only in the study stage and are generally starving for funds.

–The National Booster Program, directed by NASA, is also greatly underfunded. Under present plans, the United States would not be able to match the thrust used in the Soviet Venus launching for several years at the very least.

As one military man put it: "When you open the box and look in, there just isn't much there." ⁂

# Man May Get First Knowledge of Planet

***Promised weekly reports on instrumentation's findings could solve many puzzles***

IF THE SOVIET Venus probe is successful, it should open a whole new realm of knowledge about Earth's neighbor planet.

About all that astronomers know for certain about Venus is that it is wreathed in banks of clouds. Concerning the rest of its properties there is considerable disagreement.

The planet's rotational period may be measured in weeks—or hours.

Some scientists think the surface is completely arid; others that there may be some water.

This has led to the conclusions that there is either no life on the planet, or that it could be in a period corresponding to the earth's carboniferous period of several million years ago.

Whether this first close-up look will shed any knowledge on the existence of life forms must await the time that the probe reaches Venus—someday after April 15—and whether its instrumentation functions properly. The Russians have promised weekly reports on the spacecraft's progress.

• **Similar to Pioneer V**—The official Soviet press agency Tass describes the probe's main mission as one "to check the methods of injecting a space body into an interplanetary trajectory, to check radio communications over super-long distances and the guiding of a space station, to check more exactly the size of the solar system and to carry out a program of physical observations in outer space."

The equipment on board is reported to be designed to study cosmic radiations, magnetic fields, interplanetary matter, and to register collisions with micrometeorites. Chemical batteries charged by solar cells are said to be furnishing the power for the instrumentation and communications systems.

Thus, the scientific objectives are simple and straightforward, and undoubtedly the instrumentation used to realize them will be conventional.

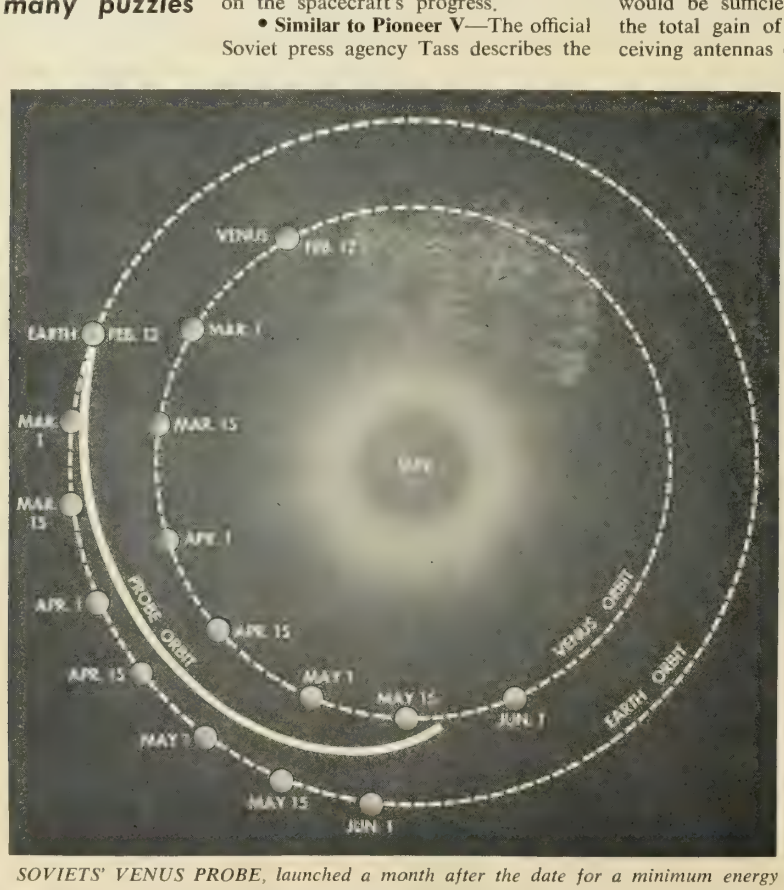
Communications over the projected 50-million-mile range should bring up no problem, especially in view of the payload weight available in the 1419-lb. probe. A 100-watt transmitter would be sufficient, by assuming that the total gain of transmitting and receiving antennas equalled 50 db.

*Pioneer V*, with a 150-watt transmitter, was expected to be able to transmit sufficiently strong signals to be received by 60-foot (28 db) antennas. The 250-foot Jodrell Bank antenna actually did receive 5-watt transmissions out to 22.5 million miles.

The power package in *Pioneer V* weighed 50 pounds and the instrumentation 40 pounds. With its total payload of 95 pounds, it was scheduled to perform virtually the same task as the Venus probe. With its much larger capacity, the Russian vehicle could reasonably be expected to accomplish many more functions and provide much greater accuracy than the U.S. effort.

• **Not much known**—Most of

*(Cont'd on P. 39)*




VANSAG

*SOVIETS' VENUS PROBE, launched a month after the date for a minimum energy orbit to the planet, is now expected to hit or pass close by Venus toward the end of April. The above chart was based on the Russians' original prediction that the vehicle would impact or go into orbit around Venus in last half of May.*

# Mariner Shot Set for August, '62

***Dryden says NASA will make sure Centaur is available; new vehicle will come close to matching present Soviet thrust***

THE RED VENUS PROBE settled one argument with a vengeance. The U.S. will fire a *Mariner* at Venus in August, 1962, the next favorable period, assuming that a *Centaur* is available by then.

Former Administrator T. Keith Glennan of the National Aeronautics and Space Administration, in one of his last official acts had pushed the U.S. target date for a Venus fly-by back from 1962 to 1964.

But Deputy Administrator Hugh L. Dryden told the House Space Committee last week that Glennan's decision did not preclude shooting at Venus if a *Centaur* vehicle is available. And Dryden told M/R that the *Centaur* launch schedule will be juggled if necessary to make a vehicle available.

Glennan's delay apparently was based on priorities, rather than funds. The Venus probe, *P-37*, had been scheduled for the seventh in the series of *Centaur* vehicles, which are to begin flight tests this summer. When it became apparent that slippage in the *Centaur* program might prevent getting seven vehicles off by August, 1962, Glennan pushed the target date back, rather than attempt to change the schedule.

Dryden told the House committee it now looks as though *P-37* will be aboard *Centaur* 4 or 5. He explained that the first *Centaur* launches must be devoted purely to checking out the vehicle and cannot carry interplanetary payloads.

• **Matching Red thrust**—*Centaur*, which will have a high-energy liquid hydrogen-LOX stage atop a modified *Atlas*, will be the first U.S. launch vehicle with capacity in the same range as the Soviet launch vehicles, based on an ICBM with about 800,000 lbs. takeoff thrust, more than twice the 360,000 lbs. of *Atlas*.

Dryden said *Centaur* will be able to launch 1000-1100 lbs. on a Venus trajectory, compared with 1419 lbs. in the Soviet Venus probe. NASA plans to have a backup vehicle available in August, 1962, if the first fails at launch. But Dryden noted that a backup shot will be impossible if it does not become apparent within a month that *Mariner* is not heading true for Venus.

The NASA official said Russia apparently succeeded in its second attempt to launch toward Venus and voiced hope that America's batting average will be as good.

Dryden recalled that NASA attempted to get a spacecraft ready for a Venus launch as early as June, 1959, but the date, seven months after the creation of the agency, made too tight a schedule. The *Thor-Able* vehicle was eventually used to launch *Pioneer V*, a 94.8-lb. spacecraft, in the general direction of Venus' orbit on March 11, 1960.

*Pioneer V* traveled within 8 million miles of Venus' orbit and within 26.1 million miles of the planet itself last year. However, the weight-carrying capacity of a *Thor-Able* left no room aboard *Pioneer V* for the heavy control and terminal guidance gear necessary to find the planet and lock onto it after a flight of more than 100 million miles. The propellant for reaction jets alone would have to weigh several hundred pounds.

*Centaur*, which will be able to launch 1450 lbs. to bare escape velocity and 8500 lbs. into a low orbit, is to have three development flights in the latter part of this year before it takes on any payload except instruments designed to monitor performance.

At one point, the NASA schedule called for Department of Defense payloads aboard *Centaurs* 4, 5 and 6. Apparently, this is the part of the program that will be juggled if necessary to make two *Centaur* vehicles available for *Mariner*.

Dryden told the House Space Committee that, so far as he knows, booster capability is the only area where U.S. Space technology is behind that of Russia. He believes, he said, that America has guidance and control gear capable of doing everything Russia can do in space, just as soon as there is thrust enough to lift it.

• **Money on hand**—Asked whether more money can speed U.S. booster programs, Dryden replied the budget is being reviewed at the request of President Kennedy. He cautioned that it will not be possible to speed very much. He predicted that the U.S. will catch up with Russia in booster capability by 1965, when *Saturn* is operational.

*Centaur* apparently has no serious budget problems. The NASA budget request submitted by former President Eisenhower includes a supplemental Fiscal Year 1961 item of $5 million in lunar and planetary exploration, most of which will go for *Centaur* vehicles to be fired early in FY '62.

Dryden noted that *Pioneer V* accomplished some of the scientific objectives the Russians assigned to their Venus probe—by measuring radiation, magnetic fields and micrometeorite density in interplanetary space. The little spacecraft holds the long-distance communication record of 22,460,740 miles, set on June 26, 1960, the last day the signal from its 5-watt transmitter could be heard with the use of the 250-ft. dish antenna at Britain's Jodrell Bank Experimental Station.

Russia's previous long-distance communication record was 396,000 miles, which the Soviets said they set with *Lunik I*, launched Jan. 2, 1959. ⌗

### *VENUS PROBE I*

| | |
|---|---|
| Weight | 1,419 |
| Internal Temp. | 68 degrees F. |
| Payload | Measuring devices for cosmic rays, micrometeorites, magnetic fields; also solar cells and transmitting equipment |
| Launched | Feb. 12 |
| ETA | April 15-30 (Revised from May 15-31) |

# Orbital Data Shows Reds Had to Use A Backup Vehicle

***No attempt made by U.S. to track spacecraft optically —shift in arrival may indicate it was off course***

RUSSIA APPARENTLY used a backup vehicle in its Venus probe.

Deputy Administrator Hugh L. Dryden of the National Aeronautics and Space Administration says the similarity between orbital elements of *Sputnik VII*, launched Feb. 4, and those of two pieces of debris from the Venus probe launched from orbit Feb. 12 strongly supports the idea that both shots were for the same purpose.

Dr. Aubrey Mickelwaite of Space Technology Laboratories, one of America's top space trajectory specialists, declared that the Venus probe must have been a backup vehicle. He said the time between the two was too short for it to be a follow-on.

*Sputnik VII* (1961 Beta 1), which Russia said weighed 14,000 lbs., had an inclination 64.90°, a period of 89.66 minutes, an apogee of 196 statute miles and a perigee of 125 statute miles, according to U.S. tracking agencies.

The debris from the probe launched from orbit Feb. 12 (1961 Gamma 1) consisted of Gamma 2, the rocket body from the previous stage; and Gamma 3 and Gamma 4, two parts of the satellite from which the probe was launched.

The rocket body is believed to have re-entered the atmosphere, NASA said. Both Gamma 3 and Gamma 4 have inclination of 65.01°. Gamma 3 has a period of 89.79 minutes, apogee of 201.5 statute miles and perigee of 123 miles. Gamma 4 has a period of 89.54 minutes, apogee of 186 miles and perigee of 124 miles.

• **Space derelict**—Dryden noted that the chief difference between the Gamma 3 and 4 orbits is in the apogees. He speculated that the parts flew apart when the Venus probe was ejected, Gamma 3 upward and Gamma 4 downward.

NASA said the rocket body of *Sputnik VII* (1961 Beta 2) has reentered the atmosphere and burned up. Another object, 1961 Beta 3, believed to have been ejected or broken off from the big *Sputnik*, is now orbiting with an inclination of 64.89°, a period of 90.09 minutes, apogee of 207 miles and perigee of 148 miles.

Beta 3—with an apogee 11 miles higher and a perigee 23 miles higher than its parent—has considerably more kinetic energy. The figures thus lead to obvious speculation that it is the derelict spacecraft ejected on the probe that failed.

The early burnup of both rocket bodies indicated the final stage and restartable engines, and that a short burst of propulsion was necessary to put the big satellites into initial orbit. For if the rocket bodies followed the satellites into orbits with perigees well over 100 miles, it is unlikely they would have fallen back so fast.

There was no reason to believe that high-energy propellant was necessary in the final stage. Mickelwaite estiated that a rocket weighing only 7,000 lbs. might have been enough, using conventional propellants with specific impulse of 290 seconds in vacuum.

• **Changing course**—Several U.S. scientists speculated that the Red spacecraft might have had some sort of midcourse guidance, although there could not have been much propellant aboard a 1419-lb. spacecraft to change course to any great degree.

One scientist suggested the change in arrival date from May to April might have resulted from a mid-course maneuver made necessary by the craft's being greatly off course. His guess was that Russian scientist ordered a burnout of all the propellant intended for attitude control and terminal course.

By late last week, none of the deep space antennas available to the West had succeeded in tracking the Red craft, since it is transmitting only once every five days, presumably when over Russia. U.S. stations at Goldstone, Calif., and Woomera, Australia, were modified to receive on the Russian frequency and Britain's Jodrell Bank was expected to do the same.

Some U.S. trackers wondered why no effort had been made to track the spacecraft optically. They noted that with initial trajectory data—or assumed data—wide angle optical telescopes such as the 48-inch Schmidt at Mt. Wilson could be aimed at the general area and pairs of exposures made at different times and compared on a blink comparator would spot movement of the image. Repeating the procedure on successive nights would establish a general trajectory and it could then be tracked with larger narrow-angle telescopes. ⌗

## Booster Program May be Speeded

RUSSIA'S NEWEST demonstration of rocket power turned the spotlight on the U.S. booster program and the possibility of speeding it up.

NASA's 1.5-million-lb.-thrust *Saturn* won't be ready to carry a payload until 1964, and won't be operational until 1965. And this is the only large booster in sight.

But Thiokol's Dr. Harold W. Ritchey says it would be possible to fabricate a 3-million-lb.-thrust solid rocket in less than three years. "If we were in a hurry," added Ritchey, "we could have it in 18 months . . . we could have it before the -XX 1.5-million liquid."

Ritchey estimated that 1-million to 5-million lbs. of thrust is about the most that could be gotten out of a single combustor using liquid fuels and a turbopump. He said that it's about as easy to make a 100-million-pound-thrust solid as a 1-million-lb. liquid.

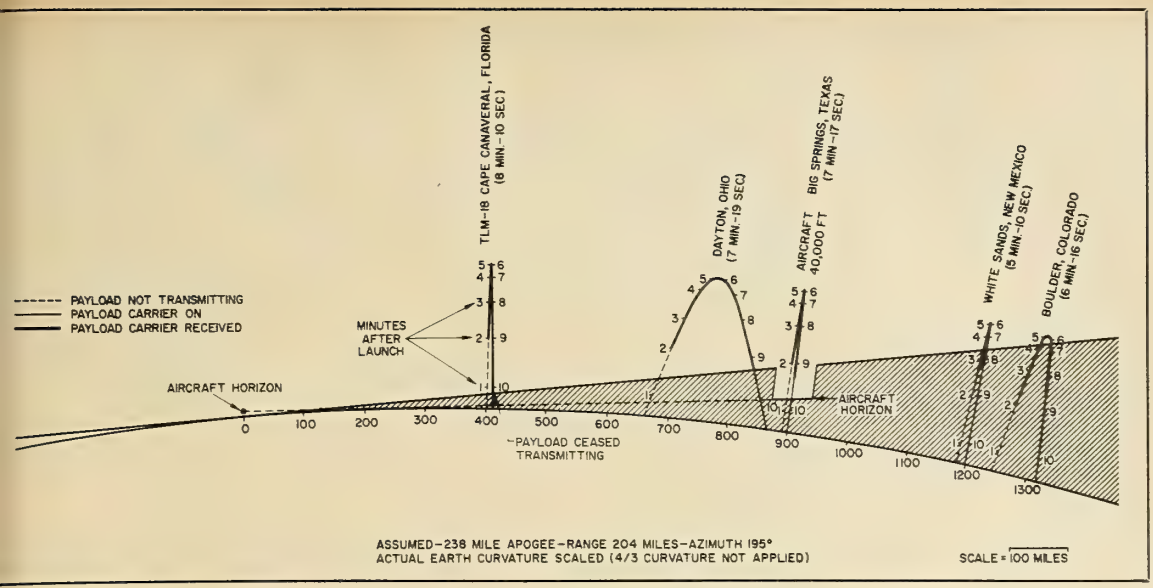
On the other hand, NASA's Deputy Administrator Hugh Dryden is not as optimistic about solids as Ritchey is. Dryden told a congressional committee last week that solids assuredly have a place as large boosters—but that one could not possibly be made before *Saturn*.

For a meaningful moon or planetary mission, Ritchey called for a payload of 120,000 pounds. He estimated that for this, the overall vehicle weight would be between 7-million and 9-million pounds. Assuming a thrust-to-weight ratio of two or more, Ritchey figured the needed thrust at 20-million lbs.

This thrust could be obtained by clustering seven 3-million-pound-thrust boosters. Ritchey indicated that this would be the quickest, easiest and least costly way of getting large thrusts.

The solid booster costs between $1.25 per pound and $2.25 per pound, Ritchey said. He figured that a 21-million-pound-thrust solid, weighing about 5 million pounds, would cost between $5 million and $10 million. He estimated that containers for liquid boosters cost about $100 per pound.

Because of the high thrust obtainable from the solid rockets, Ritchey observed that we may have been building our staged rockets upside down. "Put the solids underneath and the liquids on top." ⌗




# 'Beanstalk' Rockets for SAC Signals

## *First details of emergency communications system developed by Hughes*

Los Angeles—Advanced development is expected to start soon on a rocket-borne communications system to provide emergency transmission of the "Go" signal to SAC's retaliatory forces.

Called *Beanstalk*, the program is an outgrowth of the *Tattletale* project developed and tested last year by the Hughes Aircraft Co. Communications Division. It would be designed for use only "if all else fails."

Development of an Emergency Positive Control Communications System (EPCCS), originally under Wright Air Development Division, apparently is near the contract stage. Further work probably will be supervised directly by the 480L AIRCOM worldwide Air Force communications system.

Details of the approach taken by Hughes in *Tattletale* have now been disclosed. They were reported by W. L. Exner and E. R. Gaul of Hughes' Communications Division at the Institute of Radio Engineers Winter Convention on Military Electronics.

Hughes scientists believe that the system will operate at altitudes on the order of 1000 mi. with transmission times on the order of 20 to 25 minutes.

In some ways, *Tattletale*, *Beanstalk*, or whatever it is to be called, resembles *Minuteman* in concepts of simplicity and low maintenance. The basic vehicle is uncomplicated and, Hughes says, could be installed in hardened sites for use when required.

Original contract, awarded to Hughes in June, 1959, called for development and test of a communications payload to be carried to high altitude by a conventional sounding rocket to demonstrate feasibility of long-range UHF radio communication between the rocket and ground and airborne stations.

• **Eight rockets replied**—The test program scope involved launch of six rockets from the Air Force's Eglin Gulf Test Range. First three missions, Phase I, were slated to transmit recorded messages with ground and airborne checks at stations up to near maximum theoretical range. Initial planning also called for three additional missions, Phase II, carrying receiving equipment to permit rebroadcast of messages transmitted from the ground.

Six payloads were expended during test and two were held as spares. Program also involved outfitting of ground and airborne stations, including construction of special test equipment and manning of certain stations during tests.

The rocket vehicle was to be an off-the-shelf vertical probe if possible. To fulfill this need, six *Aerobee 300* rockets were ordered from Aerojet-General in April, 1959.

The *Aerobee 300* is a tower-launched, free-flight, two-stage boosted rocket. Booster is a standard Aerojet 2.5 KS-18000 engine. First, or sustainer stage is an *Aerobee 150*, and the second, or *Sparrow*, stage is a 1.8 KS-7800 solid propellant unit. Nearly all this rocket hardware had proved reliable over a period of years and flight characteristics were well known.

Both the 2.5 KS-18000 and *Aerobee 150* were used in unmodified form. The 1.8 KS-7800 second stage engine required some modification but operated satisfactorily in some 200 service-proof tests. Ignition of this engine was signaled by a drop in first-stage thrust chamber pressure. A conical transistion section was used to adapt the 8-in. diameter 1.8 KS-7800 engine to the 15-in. diameter *Aerobee 150*. This joining section also provided aerodynamic stabilization during final phase of the trajectory.

Total loaded weight of the vehicle, without payload, was about 2000 lbs.

The PCC payload consisted of a radio transmitter and associated equipment. The r-f energy was radiated from an integral nose-cone antenna at 240.8 mc, with a nominal power of 100 watts. In Phase I tests, the modulating signal was provided from a tape recorder in the payload. Phase II payload incorporated a diplexer and

receiver in place of the recorder to permit system operation as a real-time relay.

Following environmental tests, changes were made. For example, the power amplifier tube originally used (Eimac 4CX300) employed a 6v filament. Failure of some filaments during vibration tests indicated a stronger filament tube was required. The 28v filament version of the same tube (Eimac X578G), which has the filament wound on a ceramic spool provided the answer.

Other changes included installation of an improved type power amplifier grid tuning capacitor which prevented detuning of the power amplifier, and replacement of crystal ovens in the r-f exciter with an improved type to correct failures in these areas during vibration tests. Some structural modifications were made to reduce the effects of mechanical resonances of terminal boards, battery boxes and some electrical components.

Although more than one test site had been desired, range limitations and other problems reduced all testing to Eglin AFB, Fla.

Ground-based monitor stations were located at Rock Springs, Wyo.; Boulder, Colo.; White Sands, Las Cruces and Roswell, N. M.; Big Springs, Texas; Stillwater, Okla.; Omaha, Neb.; Cape San Blas and Cape Canaveral, Fla.; and Dayton, Hillsboro and Cincinnati, Ohio. The "local" monitoring facilities were used to establish performance data on each payload during flight with a minimum of propagation effects. Remote stations were to evaluate long-range propagation effects. Operations between stations were coordinated through land-lines and a HF radio net.

Ten installations of airborne components were made in B-52G aircraft at four SAC bases, Loring AFB, Maine; Seymour-Johnson AFB, N. C.; Travis AFB and Beale AFB, Calif. However, only five took part in any test operation.

Each test aircraft was equipped with a Hughes preamplifier, a dual track magnetic tape recorder and a 28v DC to 115v AC 60-cycle inverter. The preamplifier had a 25 db gain and a 2 db noise figure, compared to approximately 14 db for the An/ARC-34. One tape recorder track recorded the rocket signal from the AN/ARC-34 output. Second track recorded a WWV signal from the audio output of the aircraft's AN/ARC-58 receiver for a time reference.

By this time, the program was about 30 days behind schedule because of the delay in facility construction at Eglin.

*(Continued on Page 42)*



## Lockheed Eyes Space Business Possibilities

LOCKHEED AIRCRAFT Corp. is negotiating with two communications companies on the possibility of the commercial exploitation of outer space.

Board Chairman Robert E. Gross told San Francisco business leaders that the missile and aircraft company also was "considering a number of other exciting and profitable commercial space enterprises."

He declined to name the two communications companies, but said the group was meeting to study how commercial space projects could work, how to finance them and how to operate completed installations.

He urged all American businessmen to start thinking now of the effect commercial use of space may have on their particular endeavors.

As an example of the importance of space, Gross noted that Lockheed was awarded over one-half billion dollars in research and development contracts last fiscal year. This is more than the entire U.S. R&D program 10 years ago and 26 times the national total in 1940.

Lockheed has over 10,000 engineers, scientists, technicians and support personnel "devoting their efforts to space research and flights—perhaps the largest of any American firm," Gross said.

**LING-TEMCO ELECTRONICS, INC.** has acquired National Aeronautics and Space Engineering, Inc., a Los Angeles consulting firm specializing in missile base engineering. NASE will become the Missile & Space Systems Engineering Division of Temco Electronics & Missiles Co., a Ling-Temco subsidiary.

**AEROJET-GENERAL NUCLEONICS** has purchased 474 acres adjoining its present site in connection with a million-dollar expansion program. The program will include a nuclear fuel facility, manufacturing facilities and laboratories for research in the areas of chemi-nuclear, nuclear-electronic, metallurgy and plasma physics. Chandler C. Ross, Aerojet-VP and division manager, said future construction may include a test facility for nuclear space power and nuclear propulsion.

**RUST INDUSTRIAL** has changed its name to Rustrak Instrument Co., Inc., to reflect the company's broadening interest in the instrument field.

**MITHRAS, INC.,** a company specializing in research, development and manufacture in the fields of astro physics, aerodynamic heating and th related areas of electromagnetic detec tion, guidance and control, has bee formed in Cambridge, Mass. Officer in the company are members of th Naval Supersonic Laboratory of th Massachusetts Institute of Technology

**APPLIED PHYSICS LABORATORY** of The Johns Hopkins University has moved its 2-man Digital Computing Center staff into a new $230,000 building in Howard County, Maryland. The facility is built aroun an IBM-7090, high-speed digital com puter.

**THE MARQUARDT CORP.** ha created a Bioastronautics Departmen under the supervision of Jack Bitterly former head of Space Medicine, Inc

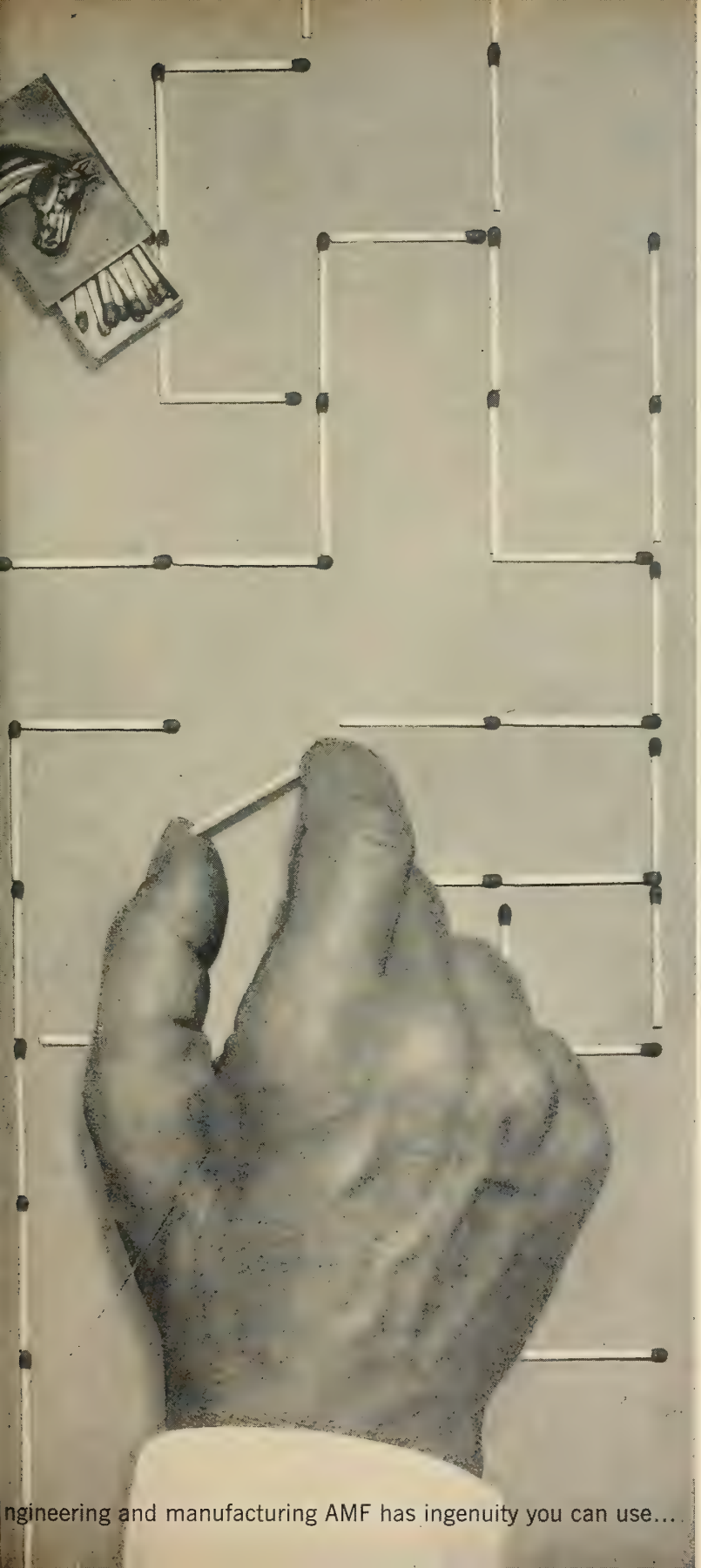
**SPECTRACOAT, INC.** ha changed its name to Optics Tech nology, Inc., and is expanding to in clude the entire field of modern optics

**ELECTRO-OPTICAL SYSTEMS INC.** has expanded its research an development facilities with a 16,000 sq.-ft. laboratory building near presen headquarters in Pasadena. The build ing will house the company's Ad vanced Electronics and Informatio Systems Division.

**AMCEL PROPULSION INC.,** sub sidiary of the Celanese Corp. o America, has completed constructio of two research and development facili ties at Asheville, N.C. A multibay high-energy building has been built fo hazardous materials, with eight high energy cells. A new static test stan capable of test-firing rocket motor producing up to 500,000 lbs. thrus has also been constructed.

**GENERAL ELECTRIC CO.** ha consolidated all its market developmen and advanced engineering activities fo the automation of industrial processes The new organization, named the Sys tems Sales and Engineering Operation will be headquartered in Schenectady

**TOOL RESEARCH & ENGINEERING,** Los Angeles, has purchased for cash the assets of the Utility Meta Products Division, Young Spring an Wire Corp. The new facility will op erate as the exotic metal product division of Tool Research, specializin in machining and fabrication of ti tanium, beryllium, tantalum, zirconium and other exotic metals.



ngineering and manufacturing AMF has ingenuity you can use...

# He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19″ rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

To insure fail-safe operation, power is required for the vacuum switches *only* during change of condition. Selection rate: 1 per second. Operating transmitters are safety-interlocked to insure a load. There are no hazards from open wires or inadvertent application of power to dead-lined antennas.

### Single Command Concept

AMF's imagination and skills are organized in a *single operational unit* offering a wide range of engineering and production capabilities. Its purpose: to accept assignments at any stage from concept through development, production, and service training...and to complete them faster...in

- *Ground Support Equipment*
- *Weapon Systems*
- *Undersea Warfare*
- *Radar*
- *Automatic Handling & Processing*
- *Range Instrumentation*
- *Space Environment Equipment*
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AMF Building, 261 Madison Avenue,
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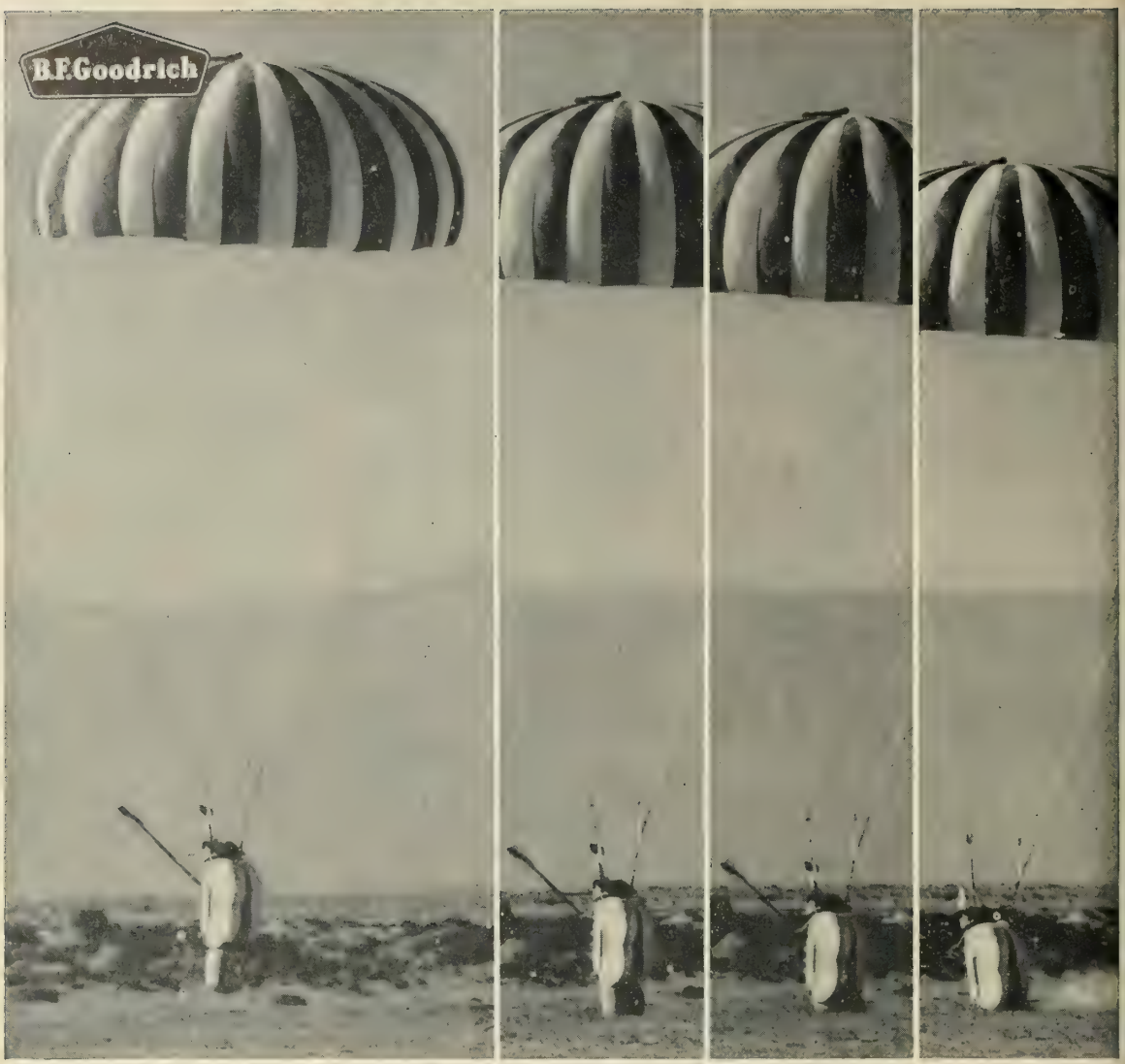



*Photo sequence shows initial series of tests of B-70 escape capsule. In last photo note dust raised at right of capsule as air escapes through "blowout" valve.*

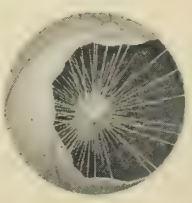
# Engineered "blowout" cushions landing

When this B-70 escape capsule hits the ground, the inflated rubber bag on the bottom absorbs initial impact—then the bag exhausts through a "blowout" valve just at the point of maximum compression to eliminate any bouncing "yo-yo" action. The bag must pack in minimum space, must inflate within 5 seconds.

B.F.Goodrich is equipped to engineer and build shock attenuator systems that meet demanding requirements like this. The systems are complete—comprising the flexible bag, valving and inflation device. Special BFG test facilities aid in engineering the right system to meet the specific requirements of load, approach speed, and tolerable G limits.

If you have a requirement for an engineered shock attenuator system check with *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Department MR-2, Akron, Ohio.*

**Use B.F.Goodrich shock attenuator systems on your advanced projects.**



- Space vehicle payload landing
- Test missile recovery
- Helicopter power failure protection
- Capsule and cargo recovery

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# Technical Countdown

## ELECTRONICS

### GE Testing Plasma Diode

Experiments with plasma diodes—thermionic converters capable of generating electricity directly from the heat of nuclear reactors—show that they can provide a sizable increase in the electrical output of nuclear power stations in the next five to 10 years. The diode under development by General Electric is a high-temperature thermionic device using cesium gas and a uranium-bearing cathode. Units capable of producing 20 watts/cm² have been demonstrated, but GE scientists say practical application is still "a long way off."

### High-temperature Semiconductor Data Released

Department of Commerce has just made available two reports on current work in the search for new semiconducting materials capable of high-temperature service. The reports—"Research on New High-temperature Semi-Conducting Materials" (PB-161-938) and "Investigation of Physical Properties of Semiconductors" (PB-161-903)—are available from Commerce Office of Technical Services.

### Moon-Bounce Marks Woomera Opening

Communication between the U.S. and Australia via the moon was demonstrated Feb. 10 in a transmission between the Jet Propulsion Laboratory station at Goldstone, Calif., and the Australian station at Woomera. The 455,682-mile transmission took 2.44 seconds, relaying a voice greeting telephoned from Washington by NASA Deputy Administrator Hugh L. Dryden to Alan Hulme, Australia's Minister of Supply. Hulme's reply, by conventional radiotelephone, was blacked out by ionospheric conditions.

## PROPULSION

### F-1 Engine Static Tested

First static test of a prototype thrust chamber for the NASA-Rocketdyne F-1 engine achieved a thrust of 1,550,000 lbs. for a few seconds—the highest thrust ever achieved in this country. The Feb. 10 test was the first of a series at Edwards AFB, Calif.

### Orbit With One-Stage Hydrogen Engine?

Pratt & Whitney contends it could develop a liquid hydrogen-LOX engine—without any real increase in bell size—which would be powerful enough to put a one-stage vehicle into orbit. The engine would be a follow-on to that used in *Centaur* and *Saturn* final stages. The only question would be where such a vehicle would fit into launch vehicle program.

### S-45 Launch Delayed by Countdown Difficulties

A faulty inverter caused the first delay in the launching of a *Juno II* to boost the *S-45* ionosphere beacon satellite. Further attempts, made during the night of Feb. 10-11, ran into trouble with sticking LOX valves. At one point, the count was milliseconds from launch when low LOX pressure actuated an automatic cutoff.

## SUPPORT EQUIPMENT

### Improved Accuracy on New Range Ship

Super-accurate location is the primary feature of new *Pershing* range ship Twin Falls Victory. Using lorac, the tracking radar can reportedly be located within 30 feet of a point at Canaveral when the ship is 300 miles down range. Ultra-precise pitch, roll, and heading measurement equipment—with accuracy equal to that of the FPS-16 radar readout—makes the shipborne radar equal to a land-based installation.

### Atlantic Range to be Extended by MARS Ships

New AMR instrumentation ships—due for contract award in the next few months—are well described by their designation: Project MARS (Mobile Atlantic Range Station). The ships will be veritable floating bases with equipment and capability equal to that of down-range island sites. Completion of ships will mark an important step in extension of the range.

### 'Heroes' Man Impact Predictor at AMR

Impact prediction facility at Canaveral is wryly dubbed the "hero" site for personnel stationed there during launches. Only volunteers man the computer center, so near the designated "danger zone." Skunks underneath the building make the duty even less desirable.

### Fail-Safe Disc Brake for Atlas Elevators

A new disc brake being built by Goodyear for *Atlas* launching platforms will eliminate the possibility of the elevator dropping the ICBM to the bottom of its silo in case of hydraulic or electrical system failure. Although the Air Force says the brake requirement is not related to the recent *Titan* silo explosion, such a device could conceivably have prevented the accident. There are no plans at present to incorporate such a brake in *Titan* launchers.

## ADVANCED MATERIALS

### Electrical Explosive Forming at G.E.

Engineers at General Electric's Schenectady Laboratories have perfected an explosive forming technique through an electrically-induced underwater explosion. The electro-spark method eliminates conventional explosives and permits the facility to operate without elaborate safety precautions.

### Finished Rare Earths Available Soon

Michigan Chemical Corp. and Dresser Products, Inc. are working together to supply rare earth materials in final fabricated forms to the nuclear, metallurgical and electronics industries. Michigan is the raw materials source and Dresser the fabricator in the joint arrangement.

### Screw Pitch Diameter Indicator Invented

A device which fits on a standard micro-caliper and permits a missile maintenance man to measure the pitch diameter of screw threads with one hand has been patented by two Huntsville men. The instrument speeds the replacement of worn screws on missiles and the accurate threading of screws on a lathe.

# Titanium to Slash Weight of Case

LOS ANGELES—The switch from steel to titanium second-stage motor cases for *Minuteman* is expected to cut weight by 30% in inert parts for the mid-section of the ICBM.

Aerojet-General Corp. will fabricate the cases in substantially the same manner it used to turn out previous steel types, but with some new advantages.

The company's work in fabrication of titanium for the *Minuteman* cases was described in a paper presented at the American Rocket Society's Solid Propellant Rocket Conference in Salt Lake City by Aerojet's H. L. Podell and R. J. Kotfila.

Thus far, Aerojet has not fired any second-stage motors with titanium cases, but has run hydrotests and other proofing methods on them. It can also fall back on the experience gained in fabricating third-stage *Minuteman* cases, which lost out to Hercules Powder Co.'s glass case in that competition.

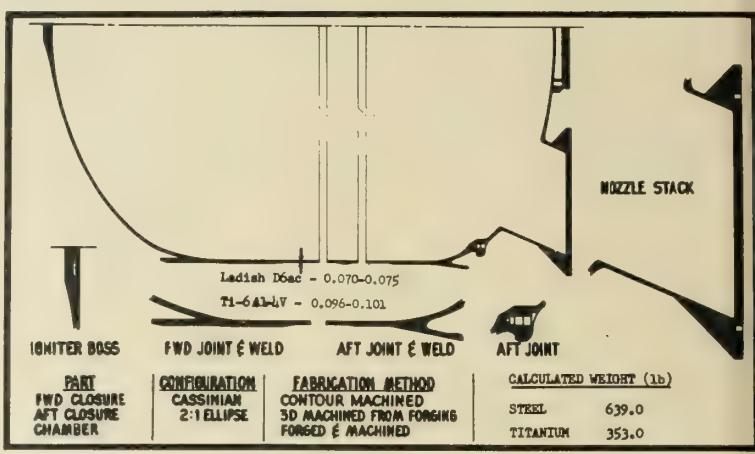
At present, the cases are made for Aerojet's Solid Rocket Plant by the Lycoming Division of Avco Corp., and Aerojet's Downey Division. Allison Division of General Motors may also begin producing them soon.

• **Significant weight cut**—With the changeover to titanium, the *Minuteman* second stage will maintain its configuration of a cassinian 2:1 ellipse, but will have a wall thickness of 0.096 to 0.101 in. instead of the steel wall thickness of 0.070 to 0.075 in. The additional thickness adds no weight, but increases rigidity and resistance to buckling.

The weight saving will be considerable, with the final titanium product weighing 353 lbs., compared with the steel weight of 639 lbs. The forward closure will be contour-machined, the aft closure will be three-dimensionally machined from the forging, and the chamber walls will be forged and machined—with the possibility that shear-spinning may be employed later.

The entire case is made from machined, rolled ring forgings joined by circumferential welds, while the heads and closures are forged from billets. The rolled-ring chamber-section forgings can be further refined by shear forming. The titanium forgings are solution heat-treated after rough machining, and all distortion occurs at this time, eliminating the need for severe heat treating after welding.

Using titanium instead of steel for the motor cases, the company estimates, can reduce weight by 30% without any loss of reliability or safety, at the same time capitalizing on the fabrication and tooling experience derived from the steel-case methods. Basic design of the chambers is the same as that for steel, the only significant change being in wall thickness.




**Second Stage Minuteman Case Configuration**

That use of several circumferential welds rather than one longitudinal weld has benefitted reliability in the program is borne out by the record—approximately 175 Ladish D-6AC steel cases made and hydrotested without a single failure.

The specific titanium alloy chosen to replace D-6AC for the second stage is Ti-6Al-4V, one of the alpha-beta group. The authors pointed out that it is only one of several groups of alloys now available, others being Ti-5Al-2.5-Sn in the alpha group and Ti-13V-11-Cr-3Al in the beta group.

Ti-6Al-4V has been used longer than the other alloys, and is easily handled, forged and welded, as well as easily heat-treated. Its only significant disadvantage is its distortion during quenching following the heat treatment.

• **Steel second-best**—Aerojet says minimum yield strength of 150,000 psi is easily attainable with good ductility. Elongation values of 10% and over are normal. Ultimate strength is 160,000 psi, uniaxial, and 180,000 psi, biaxial.

On this basis, the firm says, the effective biaxial strength-to-density ratio at ambient temperature is 1,125,000, an improvement of 45% over the previously used Ladish D-6AC steel. However, at elevated temperatures such a would be encountered during operation the difference would not be so great.

Due to the *Minuteman's* case-de sign-temperature of 300°F and above the titanium ultimate strength is de graded to 155,000 psi in a biaxial stres field, whereas steel is virtually unaf fected. The strength-to-weight ratio o titanium at these conditions is 970,000 so the net improvement over the D-6A steel becomes only 27%.

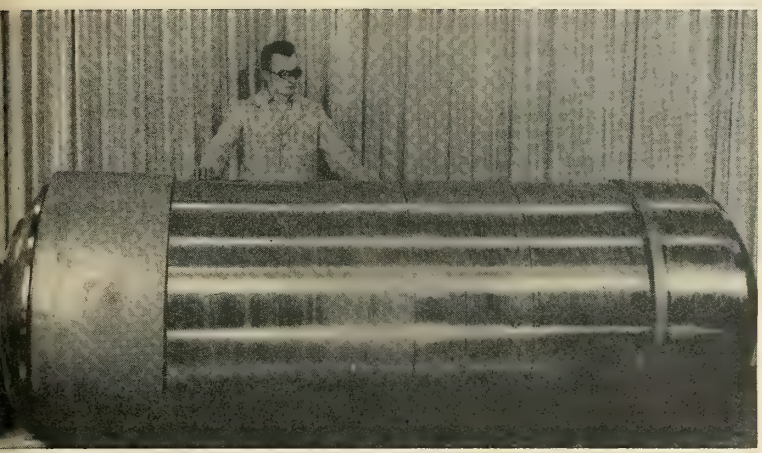
One of the more important ad vantages accruing from the change t titanium is the possibility of usin greater wall thicknesses for a give weight, for greater rigidity and bucklin resistance.

Loads placed upon the case durin missile maneuvers can cause bucklin the company pointed out, and th makes it necessary to fabricate case with greater wall thickness than woul be required merely because of intern pressure.

Aside from the 6Al-4V alloy slate for actual use, the Aerojet spokesme discussed advantages to be gained fro 6Al-6V-2Sn, an alloy of the alpha-bet group capable of higher strength tha 6Al-4V; and 13V-11Cr-3Al of the bet group. Although these show promis the company said there is possibility o welding and weld-repair problems.

Heat treatment of the Ti-6Al-4 cases is accomplished by water quench ing from the solution temperature an then aging at 900° to 1000°F. Highes

# Minuteman 2nd Stage



*COMPLETE SET OF ROUGH-MACHINED titanium forgings lined up according to final second-stage motor chamber configuration. Finished case weighs only 353 lbs.*

esponse is obtained by using a solution emperature close to the beta transus, which is 1750° to 1800°F for this alloy.

Elongation is good, and the strength of the solution-treated material, which s quite ductile, is increased from a 120,000 psi yield strength (155,000 ultimate) to a 160,000 psi yield strength and a 170,000 psi ultimate strength by aging.

Podell and Kotfila note that ductility of the solution-treated metal is encouraging from a welding standpoint; welds and weld repairs apparently could be cooled quickly without postheating and with no loss in ductility.

Aging time required by 6A1-4V titanium is quite short—on the order of eight hours—and desired properties are usually adequate after this period. Fracture toughness tests were run through a center-notch fracture toughness index ($G_c$) and the results indicated that the solution-treated and aged condition gave a value over 1000 in.-lb./sq. in., considered completely satisfactory for the application.

Nominal value of 150,000 psi yield strength for 6A1-4V, a conservative figure, is expected to produce completely successful cases.

• **Welding titanium**—A tungsten inert-gas process using wire of base metal composition, Ti-3AL, or commercially pure titanium, is used for welding the cases. When welds on solution-treated material are made with commercially pure wire, the as-welded strength is generally equivalent to that of annealed material; after aging, the strength is slightly less than parent material strength.

Welds on the alloy are excellent, the authors said, with high ductility and good fracture toughness. No problems are expected. The use of circumferential welds rather than a single longitudinal weld is also expected to improve reliability, since this type of weld cuts the hoop stress in half, and weld areas can be bolstered by thickening the joint area without great weight penalty.

Automatic equipment is utilized with the TIG system, resulting welds having a minimum of porosity and no cracking. Use of an interlocking weld joint eliminates the need for special tooling. The chamber is reinforced at the weld joint to provide twice the normal section thickness in the weld and heat-affected zone of the parent material.

Since welds in this type of case design are circumferential, the resulting stress in the weld area is only one-fourth hoop stress, and the joint design is therefore extremely conservative.

Less than four lbs. of weight has been added by use of joint-reinforcement techniques.

After welding, final strength of the titanium alloy is obtained by age hardening. Aging is accomplished between 900° and 1000°F and because no severe temperature or quenching is involved, the effects on the structure are negligible. After aging, only final machining of interface dimensions and such operations as final surface finishing and threading are required.

• **Spin forging possible**—Aerojet feels that wall thicknesses of about 0.350 in. is a minimum for sections of large rocket casings of the *Minuteman* second-stage size. Shear spinning, however, had been used to produce cases at 1000°F in two passes, from 0.880 in. thick to 0.340 in. during material evaluation tests. Further development is expected to prove that solution-treated materials can be spin-forged to essentially final thickness, offsetting the current disadvantage resulting from the severe quench and attendant distortion in solution treatment.

After the solution heat-treatment, the forgings comprising the chamber section are machined to final membrane dimensions. In contrast to steel, Podell and Kotfila said, titanium fabrication and manufacturing problems are somewhat simplified because the metal can be machined after final heat treatment. It has a tendency, however, to distort during final machining, especially where thin sections are involved.

To overcome the final machining distortion, Aerojet has developed a tracer-device technique for machining chamber walls in which the final-machined inside surface serves as a template for machining of the outside surface. Thus any slight distortion of the inside surface is reproduced on the outside surface, maintaining constant wall thickness to required dimensions.

The company has fabricated at least ten titanium chambers thus far, most of them on third stage, and is now aiming at adaptation of the second-stage design to the material. One of the third-stage units was burst-tested at pressures about 700 psi at 300°F, and two were loaded and statically test-fired. The static firings were so successful that Aerojet reconditioned the units after firing and may use them again. Another titanium chamber was recycled 25 times through the hydrotest facility without failure.

With glass and titanium rocket motor cases now becoming standard on long-range weapon systems, the use of steel may soon be confined to the smaller-size powerplants where extreme strength-weight-ratios are less important than cost. ⌘

# Hydrogen Jets Match Re-entry Heat

***Lockheed's big burner system simulates heat flux in gapless envelope, has unprecedented heat capability***

by Joseph N. Steinmetz, Jr.
*Design Specialist*
*Lockheed Missile and Space Division*
*Sunnyvale, Calif.*

LARGE-SCALE re-entry heating has been brought down to earth with the development of a massive hydrogen jet burner assembly at Lockheed MSD.

The problem was how to simulate accurately the turbulent flow heating which envelops large surface areas with thermal shock-producing heat flux. The heat-flux capability of established metal cutting torches is adequate for a number of ballistic missile re-entry simulation applications; the difficulty was in converting small-scale, highly concentrated heat environments to large-scale controllable flame fronts.

Lockheed's approach utilizing the hydrogen jet heater originated in a program aimed at solving re-entry problems in the *Polaris* program. The project grew from a small research effort to a full-scale operation at Lockheed's Santa Cruz Test Base, 40 miles south of San Francisco.

• **Adjusts to specimen**—The hydrogen jet heater consists of clusters of burner units, the quantity determined by the number required to completely envelop the structure to be tested. The burners are supplied with gaseous hydrogen and oxygen from cascades of cylinders. Remotely controlled pressure regulators provide variable pressure to the burner units as required to provide the correct schedule of heat rate vs. time.

The jet has a much larger heat flux capability than any other comparable full-scale heating method—in excess of 400 BTU/ft.$^2$-second. It can distribute this flux as necessary to produce gradients along a shell or other structure. It can also concentrate the heating in special areas as required. The heat flux completely envelops the specimen; there are no gaps in the heating between elements or sections.

The burners are flexible in that they may be conveniently clustered about any conventional re-entry shape including full-scale re-entry body structural shells.

The burner units are rugged enough to withstand their own torturous gas-fired environment. The cooling system is supercharged so that the burners could, if it were necessary, operate continuously at peak heating rates.

• **Manual and automated**—Control of the heat flux has been found to be highly accurate when the control system is skillfully engineered. Accuracy of temperature/time curves at the control thermocouple is normally within a few percentage points of the desired standard, throughout the simulation



*HYDROGEN JET HEATER facility, operated by the Lockheed Polaris project, is located deep in California's Santa Cruz Mountains. Also involved in the development were Liquid Carbonic Div. of General Dynamics and Hammon Precision Equipment, Inc*

Uniformity of heat distribution may be achieved by oscillation of the specimen. For greatest accuracy, the control system normally utilizes temperature feedback correction in the servo system. The hydrogen jet heater may also be operated manually, or by means of an open loop system whereby programed fuel and oxidizer pressures are followed from a predetermined schedule.

*Polaris* Re-entry System engineers consulted with the Liquid Carbonic Division of General Dynamics Corp. very early in the program to obtain estimates of feasibility and of the relative hazards involved in the handling and consumption of large quantities of gasses. Full-scale operations were calculated to require the consumption of peak maximums of more than 1,000,000 SCFH of hydrogen alone.

Liquid Carbonic subsequently engineered the gas supply cascades and primary manifolding. Design and manufacture of the high-performance burner units was undertaken by Hammon Precision Equipment, Inc., well experienced in torchmaking technology. Lockheed engineers had primary cognizance in the areas of valving, instrumentation, control systems and test operations.

• **Hydrogen best choice**—Hundreds of small-scale tests were run, as well as dozens of tests on full-scale portions of structure; as a result, an operational status is now well established, and basic performance characteristics have been proved. Hydrogen was selected after a number of tests revealed that it was generally superior to propane and actylene from the standpoint of handling and heat rate capability. Heating value of gasses, mass flow rate and even flame temperature are not satisfactory indices of heat rate capability, because of complex combustion phenomena.

Furthermore, while theory would seem to indicate that the mixture ought to be stochiometric, the greatest temperature/time slopes have so far been achieved through the use of excess oxygen.

A concurrent LMSD Thermodynamics Research Program has been established to investigate in detail the characteristics of the method and to provide greater understanding of the gas-fired environment.

The early history of the burner development was marked by initial failure to provide a burner unit which would survive its own environment without backfiring or overheating. It became evident that more exhaust area and greater cooling were necessary.

Hammon Precision Equipment, Inc. carried out a considerable redesign and development effort, in conjunction with Lockheed testing personnel, before a unit was evolved which performed reliably and successfully. This unit is now the basic item in the flexible hydrogen jet heater system. ⌗



*COPPER BAFFLE LEAVES protect the apparatus from the searing heat generated by the burner cluster. Water-cooled jets simulate re-entry heat fluxes.*

## Intramural Competition For Explorer IX Launching

TWO GROUPS in the National Aeronautics and Space Administration were racing late last week for the distinction of orbiting *Explorer IX*.

Launching of the *S-45* ionosphere beacon satellite vehicle slipped a week and was running neck and neck with *S-56*a 12-ft. balloon designed to measure drag an dthus the density of the thin atmosphere at satellite altitudes.

The *S-45* was to be launched with a *Juno II* from Cape Canaveral. The *S-56* was to be launched with a *Scout* from Wallops Island, Va. There was a possibility that both might be orbited in the same day.

The *S-56* balloon, a small version of the *Echo* communications satellite although designed for a different purpose, was to be launched into an orbit with apogee of 1400 miles and perigee of 400 miles. Since the balloon weighed only 15 lbs., despite its 12-ft. circular cross-sectional area, the thin atmosphere at altitude would have a measurable drag—something less than a thousandth of an ounce.

As a result of the drag, the satellite will lose energy much faster than do ordinary satellites, which pack their weight into a package with much smaller cross-section. Also, because of its spherical shape, the drag on *S-56* will be the same regardless of its attitude.

• **Storm study**—The *S-56* results also can be expected to shed new light on the nature of solar storms. Calculations based on the orbits of both Soviet and American satellites since the beginning of the International Geophysical Year have shown that the storms—which spew out great clouds of protons and other atomic particles—affect the density of the earth's thin outer atmosphere. The density is also affected by the time of day, time of year and latitude.

The primary purpose of the *S-56* launching, however, was to test the capability of the *Scout* vehicle. It was the fourth in a series of eight flight tests designed to complete development of the all-solid vehicle, and the second attempt at achieving orbit.

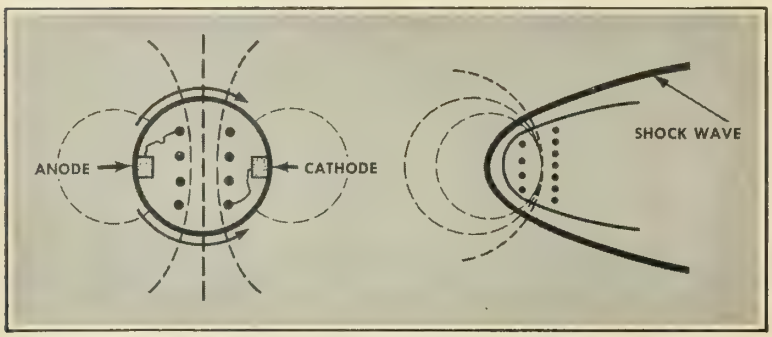
As *Scout* was phasing into the NASA launch program, *Juno II*—with approximately the same capability—was phasing out. The *S-45* ionosphere beacon was the next-to-last satellite intended for *Juno II*, a combination of the liquid-propelled *Jupiter* and three solid upper stages.

The final *Juno II* satellite will be *S-15*, designed to orbit a gamma ray telescope next month. One backup vehicle is on hand if either *S-45* or *S-15* fails. ⌗

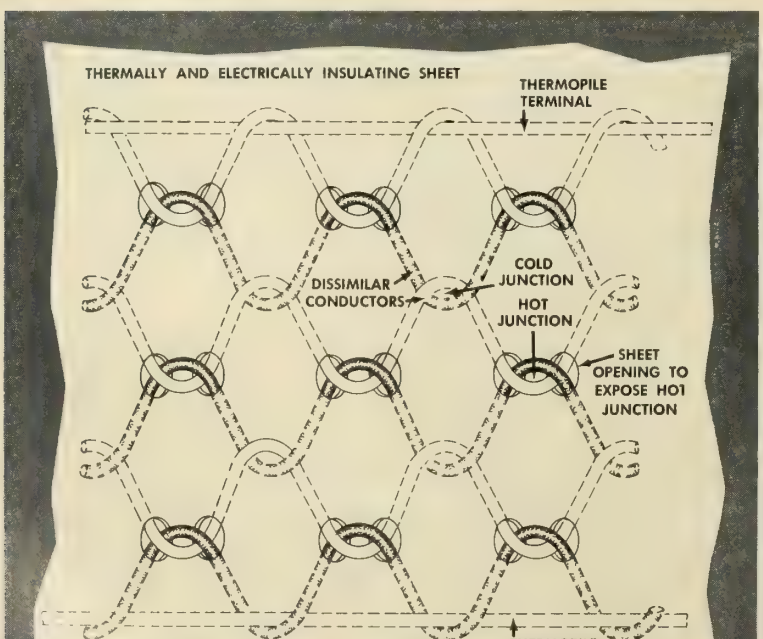
# Magnetic Field To Slow Spacecraft

## *Cook proposal would convert heat energy into electric power generating retarding force*

by William Beller




*ONE MAGNETOHYDRODYNAMIC device proposed to decelerate or control low orbiters and re-entry vehicles uses a coil to generate the magnetic field.*




*AS PART OF A MISSILE NOSE, a thermopile woven like a piece of cloth would have its hot junctions heated during re-entry, thereby generating an emf.*

MORTON GROVE, ILL.—Use of a self-generated magnetic field is being proposed as a way to slow down a spacecraft while it's in a low orbit or re-entering.

If the scheme works, some of its advantages will include: a satellite's orbit will be easily changed, because the magnetic field will be controllable; the system will have high reliability, because it will have no moving parts; and installation will be very simple, because the magnetic-field generator will wrap around a structure as easily as a piece of cloth. In fact, the generator will look like a piece of cloth.

The physical theory is simple. A thermoelectric generator converts heat energy—coming in as radiation from the sun or created aerodynamically during re-entry—into electricity. In turn, this energy is used to generate a magnetic field, which—moving swiftly through ionized particles—produces a retarding force on the space vehicle.

• **Heat retards missile**—In 1958, two Cornell University scientists—E. L. Resler, Jr., associate professor of aeronautical engineering; and W. R. Sears, director of the graduate school of aeronautic engineering—pointed out that if a fluid is a conductor of electricity, an "electric body force" may be produced in it which will affect the fluid flow pattern.

The principle involved is more familiar when a wire rather than a fluid is thought of as the conductor of electricity. Here, we have the "ponderomotive effect" or "motor effect" of electromagnetism, which is used in measuring instruments, electric meters, electric motors and other devices.

Partly as a result of the work of the two Cornell scientists, and of their suggestion that the electric body force might be useful in slowing re-entering missiles, Cook Research Laboratories is making the new proposal.

In fluids, the flow of current takes place through a volume rather than along a wire. Therefore, the electric body force per unit volume is proportional to the vector cross-product of current density and magnetic field strength.

In turn, the current density is directly dependent on the conductivity of the gas and the vector cross-product of velocity and magnetic field strength. All of these factors can be present in the neighborhood of a high-speed re-entering vehicle. Therefore, an electric body retarding force can be generated.

The high speed of the re-entering vehicle produces high temperatures around the vehicle. Air at these temperatures becomes ionized, increasing its conductivity. This takes care of the first factor.

The second factor is already taken

care of. The third—magnetic field strength—can be generated out of the thermal energy created during re-entry. If the magnetic-field strength is large enough, a considerable retarding or drag force can be impressed on the missile nose cone. This is the concept behind Cook's proposal.

• **Magnetic field in a cloth**—Cook feels that the major drawback to the theory of magnetohydrodynamic retardation has been the difficulty of producing magnetic fields of sufficient strength. The approach described by Resler and Sears envisions a missile nose enveloped in a layer of hot, ionized gas. Then some means, such as a permanent magnet or a storage battery, is used initially to produce a magnetic field.

Next, the motion of the magnetic field produces an emf. Since the air is hot and ionized, its conductivity will permit a current to flow from the anode —which is in contact with the air stream—through a coil to the cathode, also exposed to the air flow. Then the current flow through the coil induces a magnetic field around the nose of the missile. In principle, the theory is similar to that of a self-excited dc generator.

The maximum strength of the magnetic field is obviously limited by the saturation point of the electromagnet. In addition, the resistance of the electrodes and the coil may be many times higher than that of the surrounding ionized air. This would result in a short circuit—and no current flow through the coil.

To overcome the problem of electrode and coil resistance, Cook calls for a thermopile generator, consisting of a large number of thermoelectric power sources which, by the Seebeck or thermocouple effect, generate an emf.

Cook's unique construction of the thermopile takes the form of a piece of fabric. Two dissimilar metal wires are woven to form "hot" and "cold" junctions on alternate sides of an insulating sheet. Each pair of junctions is connected in a series path between two terminals. The current capacity of the thermopile is thus directly proportional to the number of these series paths connected in parallel.

For magnetic fields of considerable strength, large currents are needed. Cook says that these can be supplied by short-circuiting the thermopile, with no need for additional electromagnetic windings.

The possibility of using the interactions of moving magnetic fields and ionized particles to retard space vehicles is attractive. But to make it practical requires extensive R&D. ⌗

# Titan's 5000-mile Success Gives System Push Forward

MID-1961 operational date for the AF *Titan I* appeared much closer to reality after last week's successful 5000-mile flight. The advanced-J *Titan* fired from Cape Canaveral Feb. 10 was the first success for the new series in three tries. Previous aborts were due to failure in second-stage ignition.

The successful launch and full-range flight of the *J-11* successfully tried out several new items. Primary objective of the tests was to check overall performance of the ICBM carrying—for the firsttime—the lighter General Electric Mk 3 nose cone. Operational models will carry the Avco nose cone used on previous R&D flights.

The *J-11* also carried a stroble light for more accurate trajectory determination. This flashing red light, rated at 22 megacandlepower, was triggered on during the final phase of second-stage flight—about 300 miles downrange. Tracking cameras photographed the winking light as a curving line of dots against a background of stars.

Analysis of the position of these marker dots in relation to certain stars will provide extremely precise data on speed and trajectory of the missile—much more precise than is possible with radar. Previous delays in the test flight, originally scheduled for the week before, were due to lack of the perfect weather necessary for full-range photographic coverage.

• **Earlier take-over**—Although no details are available, it was learned that the radio-command guidance system in the *J-11* assumed control during the first-stage phase of the flight, rather than during second-stage as is usual. Presumably, the early take-over will be used in the operational system.

Also, the flight carried for the first time a new model of the three-axis gyro reference system. Several design modifications have been incorporated for improved accuracy and reliability. Changes include a new gyro flotation fluid (bromolube), and a transistorized circuit which minimizes gyro drift due to troquer hystereseis. The "strapped-down" reference system was mounted on a new vibration-isolating mounting rack which protected the gyros from vibration and G-loading effects. Structural and circuit changes in the timer package and addition of a spin-motor detection circuit (to indicate gyro operation prior to launch) were also made to the system.

An additional new feature of the A-J was an ablative skirt on the bottom half of the second-stage thrust chamber. Earlier engines had a "wet-jacket" chamber. These required the fuel used for regenerative cooling to be pumped through the stainless tubes which form the thrust chamber prior to flight. The new skirt helps minimize pre-launch preparations by allowing a dry-jacket start of the second stage engine.

The AJ also has different umbilical disconnects and uses the General Electric impact predictor.

The advanced-J series is virtually the same as the operational model *Titan I*. One other series—the M—will be fired in the R&D program. The M will be almost identical to the AJ except that it will carry the *Titan II* inertial guidance package. Its primary function will be to prove out the new guidance system.

• **Scheduled switch**—The *Titan I*, scheduled for operational status this summer, will be used in the first six operational squadrons. These will be surface-launched versions with radio-command guidance.

The silo-launched *Titan II*, with interial guidance, will be used in all later squadrons. First test-flight of the II—a full-stage bird—is scheduled for this fall. Work will begin soon on modifications of complexes 15 and 16 at Cape Canaveral to handle the new missile.

The *Titan II*, with better than twice the payload capability of *Titan I*, will use storable fuel (UDMH and hydrazine) and have about the same reaction time as *Minuteman*. It will be 18-20 feet longer than the I and stand approximately 115 feet high. ⌗

## Norair Slated to Get Mach 14 Wind Tunnel

A MACH 14 wind tunnel will be in operation early next year at Northrop Corp.'s Norair Division, Hawthorne, Calif.

The facility will be the fifth of its kind in the U.S. Norair engineers will investigate re-entry phenomena with the equipment, which will provide temperatures up to 3200°F and pressures in the area of 3000 psi for 30-second periods.

Also slated for study are opitmum hypersonic vehicle designs, deceleration and recovery methods, heat transfer techniques and micrometeorite penetration. Materials and structures will be tested under conditions of interplanetary flight. ⌗

space medicine

# NERV Data Alters Thinking on Shielding

***Low-energy protons in near Van Allen belt more numerous than expected; manned projects already call for good protection, unmanned vehicles may be given more***

by Jay Holmes

THERE ARE MORE low-energy protons in the lower Van Allen belt than had been believed, meaning that more shielding probably will be needed on solar cells and other electronic components of spacecraft.

This is one of the facts contributed by the *NERV* (nuclear emulsion recovery vehicle) experiment conducted by the National Aeronautics and Space Administration last September.

Dr. John E. Naugle, radiation expert who directed the experiment, reports that the slope of the Van Allen proton flux curve turns sharply upward for particle energies below 20 million electron volts (mev).

Naugle said that although additional shielding appears to be necessary for unmanned vehicles, the *NERV* results do not affect projected shielding for manned spacecraft, except to confirm previous knowledge about high-energy radiation. It was already known that heavy shielding will be required to absorb virtually all high-energy radiation and thus reduce to a minimum the danger in passage through the belts. Naugle said it is still true that a manned spacecraft probably will not be able to pass through the belts more than once or twice without serious hazard to the occupants.

The most complete earlier measurement of the lower Van Allen belt was made by Stanley C. Freden and R. Stephen White of Lawrence Radiation Laboratory, at Atomic Energy Commission center at Livermore, Calif., who made measurements with an emulsion package which was boosted to 750 miles altitude by a *Thor-Able* rocket in April, 1959, and later rode as a "passenger" aboard an *Atlas*.

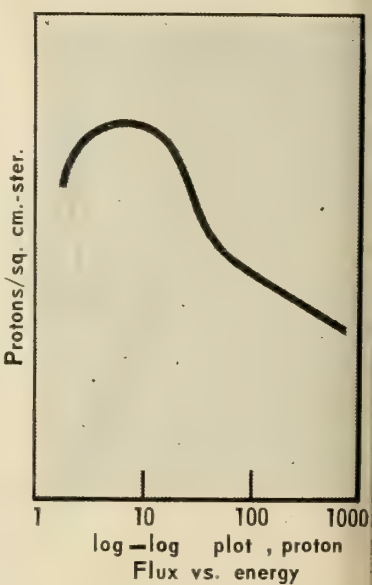
Freden and White reported that the flux of protons per sq. cm.-ster. varied with proton energy to the power −1.84—so that the log-log plot of protons against energy was a straight line with a downward slope of 1.84. However, their first results were only for protons with energy greater than 40 mev.

It was generally assumed that the plot would be a straight line throughout. However, Naugle said *NERV* results showed a bend in the plot for below 20 mev. His first plot shows a log-log slope of 3.7 downward, Naugle said.

• **Two classes**—The likely explanation for the bending, the NASA scientist explained, is in the two classes of neutrons found in the lower Van Allen belt. One class, known as "knock-on" neutrons, results from direct collisions between nuclei near the earth and cosmic ray particles that come in from the sun and outside the solar system. If the cosmic ray particle has energy of 25 mev or more, it knocks one or more neutrons out in the extremely short period of $10^{-23}$ second, leaving the nucleus in an excited state. Such "knock-on" neutrons occur in the same frequency as the cosmic ray particles.

The second class of neutrons is called "evaporation" neutrons. Those come out from the excited nucleus also in a very short time, but a little longer than required for "knock-on" neutrons. And they do not come out all at once.

Naugle said evaporation neutrons have a Maxwellian distribution—they are distributed in a random statistical way, according to a curve with the peak in the middle, trailing off at the high and low sides. As a result, he continued, the proton flux curve is expected to flatten out and trail down again in the low-energy region, so that it looks something like this:




Naugle plans to carry his figures down to 6 mev to determine whether the plot bends over as he predicts.

• **Heavy dosage**—In a paper given last fall at the Los Angeles meeting of the Society of Automotive Engineers, Naugle and Dr. Homer E. Newell, NASA deputy director of space flight programs, estimated that the radiation level in the inner Van Allen belt is more than 20 roentgens per hour.

They reported that the energy spectrum is flat and that a large amount of shielding would be required to protect a man in the inner zone. To reduce the radiation level to 0.5 r/hour inside a compartment 4 ft. in radius, they calculated, would require 45,000 lbs. of shielding.

For comparison, the Atomic Energy Commission has established limits of 0.3 roentgen a week, 3 roentgens a

quarter and 5 roentgens a year for industrial radiation workers.

Thus, in 10 hours a man would receive his allowable annual dose even with 45,000 lbs. of shielding.

In the outer Van Allen belt, the particles consist mostly of high-energy electrons. These can be stopped by a much thinner layer of shielding than is necessary for protons. But electrons, when they strike other matter, produce X-rays by a process called bremstrahlung. Thus the best shielding in the outer belt would be a light material to stop the electrons and a thin layer of lead inside that to absorb the X-rays.

Newell and Naugle reported that the electrons in the outer belt reach a maximum of almost 200 r/hour. A carbon shield weighing 60 grams/sq. cm., they calculated, would reduce that to 1 r/hour of X-rays. An inner layer of ¼ cm of lead would reduce this dosage by a factor of 10, they added.

Outside the radiation belts, the dosage will be equal to the cosmic ray background level of 5 to 10 r/yr. But figuring shielding is difficult there because solar cosmic ray outbursts occur at random. Newell and Naugle said they are very encouraged, however, by a method developed by Kinsey Anderson of the State University of Iowa for predicting periods when a solar flare is unlikely. The Anderson method is based on study of the size of sunspot penumbra.

• **'Storm cellar'**—As for protection against solar flares that might occur nevertheless, they said the best concept seems to be the "storm cellar" envisioned for the *Apollo* spacecraft. This is a central compartment just large enough to hold the man or men, with special shielding that would be supplemented by the structure of the craft.

The two NASA scientists pointed out that only about a year or so remains for obtaining data about solar radiation and its effect on living organisms—before the sun enters a three- or four-year period of quiet. By 1967, when the sun begins to become active again, development of the craft for the manned circumlunar mission will have to be well under way.

NASA's Office of Life Sciences Programs has plans for a series of experiments to fill the need. The next *NERV* to be launched late this summer from another *Argo D-8* sounding rocket, will carry several living organism samples, as well as nuclear emulsions. Other plans call for deeper space probes that might be launched with *Jupiter*, *Redstone* and possibly *Scout*

• **More funds?**—It was understood that some life sciences experiments proposed by NASA were cut out of the Fiscal Year '62 budget as proposed by former President Eisenhower but might be restored in the new budget request to be made by President Kennedy.

NASA life science specialists said they also plan to keep close watch on results from the Air Force *Discoverer* program.

In future years, the civilian space agency plans to launch larger recoverable spacecraft, with much more in the way of biological specimens aboard. Launch vehicles involved may include the *Atlas-Agena B* and the *Saturn C-1*.

The *Saturn C-1* will come into play when NASA makes the first re-entry tests of the *Apollo* spacecraft. It will be possible to carry a number of biological specimens as passengers on such flights, tentatively scheduled to begin with the eighth *Saturn* in late 1963.

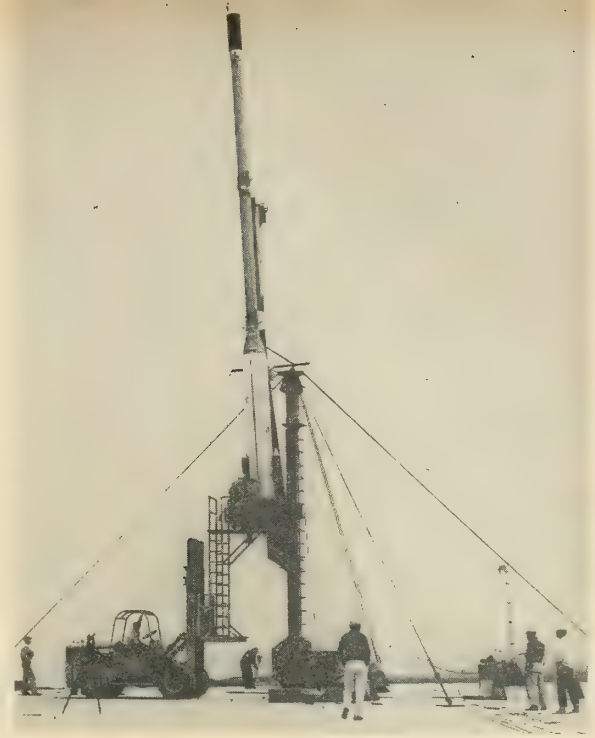
There probably will never be a "biological satellite," a life sciences specialist said, because it isn't practical to design a satellite for that purpose alone. He said *Discoverer* is excellent for testing specimens passing through a low polar orbit. The orbital *Mercury* flights, first with chimpanzees and later manned, will provide the information needed about radiation reaching down below the lower edge of the Van Allen belts.

However, it already seems reasonably certain that the radiation danger in those regions is fairly small. Still necessary will be probes that go deeper and deeper into space and return with packages of living specimens to be examined.

Dr. G. Dale Smith, program coordinator in the Office of Life Science Programs, says life scientists have some reservations about applying physicists' data on shielding until living specimens have actually been exposed to the conditions in space.

"We don't doubt the findings of the physicists," he said. "We just want to wait and see that they are borne out by experiment."

Dr. Smith said specimens must first be exposed on earth to radiation similar to that found in space. Then they will be launched—protected by the amount of shielding that seems indicated. ⌘



*ARGO D-8 rocket by Ryan Aerolab waits for Sept. 19 trip down Pacific Missile Range carrying NERV experiment. GE designed the capsule.*

## Maximum Allowable Radiation Doses and Some Typical Levels

| | Roentgens |
|---|---|
| Maximum per week | 0.3 |
| Maximum per quarter | 3 |
| Maximum annual | 5 |
| Maximum emergency | 25 |
| Normal sea-level background | 0.001/day |
| Normal interplanetary space | 5-12/yr. |
| Heart of inner belt | 24/hr. |
| Heart of outer belt | 200/hr. |
| Solar flare | 10-1000/hr. |
| Total for flare | 2-400 |

# Experts Fear Venus Contamination

by Heather David

OFFICIALS OF THE National Aeronautics and Space Administration last week expressed fear that the planet Venus would be seriously contaminated with earth microorganisms if the Soviet probe has not been sterilized.

If it has not, landing of the vehicle could render the planet virtually useless for further study in the search for extraterrestrial life. A NASA spokesman said there is a good possibility that the Venutian atmosphere would support the multiplication of earth organisms, making it impossible to find out what forms of life originally existed. Or, worse, the earth-originated bacteria might thrive and wipe out native life.

It might also wipe out existing life forms which might be edible by colonists from earth.

Soviet scientists previously announced that *Lunik II*, which they reported hard-landed on the moon Sept. 13, 1959, was completely sterilized. To this date, there has been no disclosure as to how they accomplished this or whether the same method was used in the latest launch.

A number of studies of this probem are being conducted in the United States. Generally, scientists agree that there are three types of methods: Radiation, heat and chemical compounds. Probably a combination of the three eventually will have to be used, according to NASA.

Dr. E. Staten Wynne, Chief of the Microbiology-Cellular Biology Branch of the Air Force School of Aviation Medicine, told a recent study group that scientists must discount the idea that ultraviolet radiation in space would kill any organisms in an unmanned vehicle.

Ultraviolet radiation would be effective only against organisms on the outside of the space probe, he pointed out, and in space actually aid the preservation of microorganisms.

Heat of entry into the atmospheres of Venus or Mars can not be counted on to sterilize the vehicles, since their atmospheres are composed of nitrogen, with only a trace of oxygen in the case of Mars, and of carbon dioxide in the case of Venus.

Wynne called for terminal sterilization, particularly of the interior of any space vehicle. He described a study being carried out by the School of Aviation Medicine of the bacterial content of the interiors of hermetically sealed electronic components used in space probes.

The best way to sterilize a space vehicle, he said, is probably to use ethylene oxide in a plastic bag enveloping the vehicle, its metal fairing and if necessary, the third-stage rocket. After exposure to the sterilizing vapor, the plastic would be cut away and the ethylene oxide gas surrounding the vehicle would disperse. If the interior were also being sterilized, the disinfectant could be displaced by sterile air drawn through an appropriate bacteria-tight filter, such as cotton or spun glass. On launch the fairing would be recontaminated, but would act as a shield to prevent contamination of the remainder of the probe.

Hermetically sealed components present a special problem. Preliminary studies with capacitors, Wynne disclosed, demonstrated that ethylene oxide sterilization was by far the most effective, since heat and radiation impaired performance in some components.

• **Animal carriers**—If there is danger from organisms lurking on vehicle surfaces, the potential carried in the intestines and organs of mammals is fantastic. A group of Jet Propulsion Laboratory experts have gone so far as to describe the number as $10^{12}$ microorganisms per kg of mammal intestine.

Since the moon's surface is 4 x 10 $^{13}$m, microorganisms from one splattered or otherwise deceased mammal could create a serious problem.

Walter Reed Army Institute of Research has been carrying out experiments in raising germ-free animals, however, and future U.S. animal probes which might be landed on another body would probably come from such a source.

• **Mutual contamination**—Just as there is the danger of contaminating another planet with earth "basties," there also is the threat that probes returning with samples from other planetary bodies will also carry dangerous visitors. The same threat exists that such unwelcome passengers would be carried on round-trip vehicles.

Estimates on how dangerous this could be range from obliteration of the human race to not at all. However, it is a chance no scientist will take.

Part of the study carried out by NASA is on the possibility of a "built-in" antiseptic factor which would sterilize returning probes before they landed on earth.

• **What is being done**—At present there is no authoritative body which can dictate the use of proper methods to insure against biological contamination.

Several years ago, the International Council of Scientific Unions established a committee called CETEX to study the problem. CETEX has made recommendations and drafted a code on proper procedures, but it has no regulatory authority.

NASA has pledged itself to follow the recommendations of the committee and is performing studies on its own. Although the European space programs are not thus far developed, it is interesting to note that an upcoming British conference on hospital sterilization methods plans to include a session on space probes. ⁂

## Dust in Near Space May Annoy an Astronaut

COMMON HOUSEHOLD-type dust may be a problem the astronaut will have to contend with in Earth orbital flights.

Dr. Fred Whipple, head of the Smithsonian Astrophysical Observatory, reported finding an amazing concentration of space dust in near space. The concentration is from 100 to 10,000 times that encountered at a distance of 10 Earth radii.

The dust picks up heavy charges from the Van Allen belt and swells into weak structures, "cosmic puffballs," which are drawn into an Earth orbit at about 8 miles per second.

Although the dust itself would present no hazard, the astronaut would hear the constant "pings" as the specks bombard the shell of the capsule as it traveled at orbital speed.

Dr. Whipple told the Medical and Biological Aspects of the Energies of Space symposium that a solution would be to build a "space bumper," a thin outer shell beyond the main walls of the space vehicle with acoustical insulation to dampen the pings. ⁂

# North American Aviation's

# Missile Division

# is now the

# Space & Information Systems Division

**This is the Division** that developed and is producing America's first successful air-launched strategic guided missile—SAC's GAM-77 Hound Dog—and brought it from drawing board to powered flight in just 21 months.

**This is the Division** that laid the foundation for a large part of America's current missile/space technology. Many of today's breakthroughs in aerodynamics, high speed flight, inertial guidance, large rocket boosters, materials, and manufacturing methods and equipment stem from original development work done by the Division.

**This is the Division** where the scientists of the Aero-Space Laboratories are seeking the keys to satellite rendezvous, refined trajectory analyses, space environment knowledge, lunar morphology, and materials to withstand space conditions.

**This is the Division** where intensive studies are underway on manned and unmanned space exploration vehicles, anti-ICBM projects, and information processing systems.

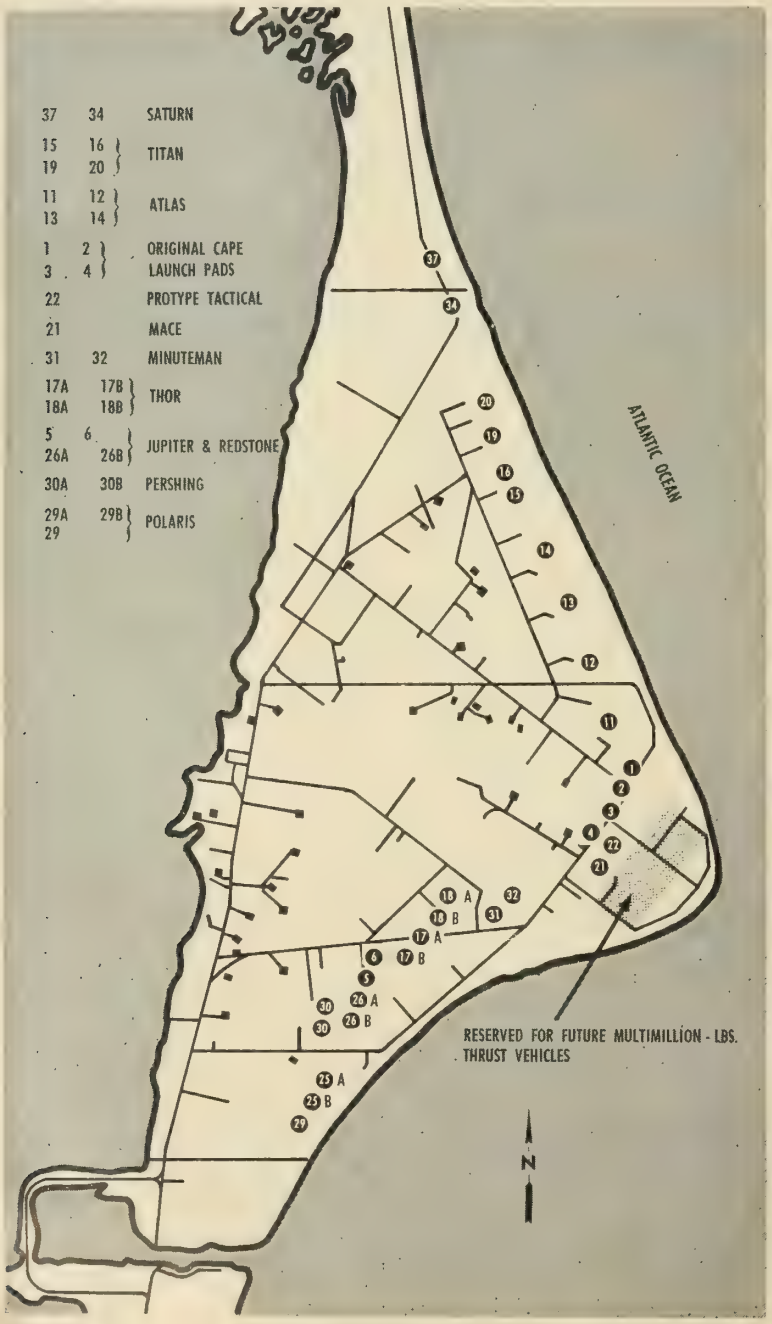
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## SPACE & INFORMATION SYSTEMS DIVISION

## NORTH AMERICAN AVIATION, INC.

# Cape Test Scheduling Is Tribute t




***Military services and NASA arrange firing dates with minimum of conflict; tight timetables will get tighter***

CAPE CANAVERAL—Scheduling of up to 6000 tests a year on the Atlantic Missile Range, an assignment fraught with danger of interservice and interagency rivalry, is performed with remarkably little friction.

Growing use of the range, to another record number of tests in 1961, is expected to place even greater strain on existing facilities. But range schedulers still expect to be able to satisfy the demands.

Three services and the National Aeronautics and Space Administration launch rockets and test instruments using facilities at the Cape and 11 downrange island stations, search and spotter aircraft and ships at sea.

A small group at Patrick AFB and the Cape matches a complex set of boards representing scores of requirements for use of radars, Azusa, ships and aircraft for long and short periods of time to produce schedules satisfactory to everyone concerned most of the time.

*Mercury* and *Minuteman* are the highest priority projects in active testing, but dozens of others have varying degrees of importance that make it possible to decide conflicts between scheduling requirements. Occasionally, however, there is a direct conflict between two tests with similar priority.

In such a conflict, the Range Scheduling Division of the Air Force Missile Test Center, headed by Lt. Col. Charles R. Carter, tries to work out an agreement between the two launching agencies. If they can't agree, the scheduling office makes a decision. Occasionally, the decision is appealed to the center's deputy commander for tests, and occasionally to the center commander, Maj. Gen. Leighton I. Davis. So far, no appeal has ever gone higher.

• **Advance notice required**—Satellite and long ICBM launchings require the

# ooperation

ongest lead time in scheduling. A long CBM shot past Cape Town into the ndian Ocean, for example, requires liplomatic clearance about a month eforehand. Some satellite shots require oreign notification beforehand.

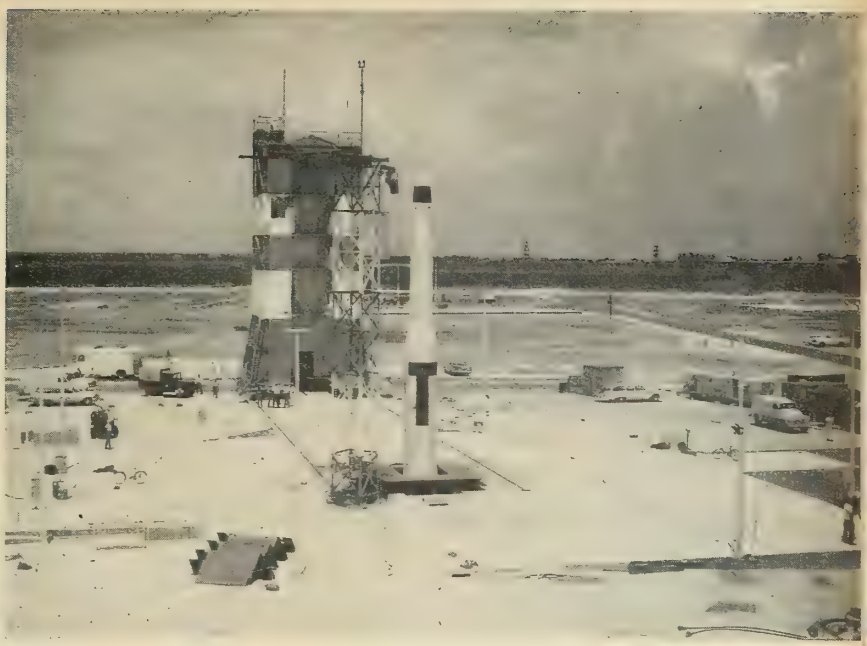
The range requires users to give general indication of plans up to a year efore launch. Six months beforehand, sers are expected to pinpoint a launch late, although revisions are allowed. The date must be fairly accurate within hree months and, less than 30 days eforehand, it cannot vary more than day.

During the month before launch, upport vessels and aircraft are ordered o station. Next, the schedule is checked vith the Federal Aviation Agency, since major Miami-Washington air route goes over the ocean 50 to 75 miles downrange. Planes are not rerouted all day for a launch. Instead, the Miami raffic controller is advised of the progress of the countdown.

Fifteen minutes before a major aunch from the Cape, north-south air raffic is rerouted inland. If a count-down is holding at T-20 minutes, the raffic controller acts as though he has only 20 minutes to get his planes out of the way.



*T. COL. Charles R. Carter heads FMTC's Range Scheduling Division.*



*RECENT ADDITION AT CAPE is launch complex for Minuteman flight tests. Bird fired Feb. 1 is shown on one of two above-ground pads. There are also two silos.*

• **Brainstorming**—Every Wednesday, the range schedulers start work on the schedules for the following week. The operating office, at the Cape, is headed by Maj. George Perkins, and reports to Col. Carter at Patrick.

Perkins' group, consisting of five Air Force officers and five Pan American and RCA employes, match their boards together and make up a tentative schedule for consideration by representatives of range users at a Thursday afternoon meeting. Dwight Sliger of Pan American, chief of the civilian group, is responsible for saying what facilities are available and what the range can or cannot do.

Some of the satellite shots require clearance by the Pacific Missile Range, since their tracking facilities are in use. The Wallops Island station, now that it fires the *Scout* vehicle, must occasionally clear with AMR for use of downrange stations.

For every major launch, there are 20 to 30 minor instrumentation tests that use fewer facilities. The instrumentation tests, naturally, have lower priority than a major launch. But once a test is on the week's schedule AMR is reluctant to move it around. "We have to maintain a semblance of order on the range," says Carter.

Before every major launch, there will be dry runs—which tie up the range just as much as the actual launch. Before the complete dry run, each major system is checked out individually. This operation occupies the facilities.

Finally, there are static tests.

• **Typical complication**—To illustrate the complexity of a schedule for a major launch, Perkins outlined these requirements for a *Mace* flight test:

Radar—2 Mod 2's at Stations 1, 3, 5, 7, and 9; FPS 16 at Stations 3 and 5.

Telemetry antennas—TLM 18 at Station 1; tri-helix and Stations 3, 5, 7 and 9.

Telemetry receivers—10 at Station 1, 4 each at Stations 3, 5, 7 and 9.

Tape recorders—4 at Station 1; 2 each at Stations 3, 5, 7 and 9.

Signal strength and center frequency recorders—2 at Station 1; 1 each at Stations 3, 5, 7 and 9.

Discriminators—up to 71 at Station 1.

Decommutators—up to 11 at Station 1.

Direct write recorders—up to 5 at Station 1.

Oscillographs—up to 15 at Station 1.

DM/Pulse amp converters—2 at Station 1.

Range safety high power command —Stations 1, 3, 5 and 7.

Range safety low power command —Stations 1 and 9.

Automatic switchover capability—Stations 1, 3, 5, 7 and 9.

TV skyscreen—Station 1.

Mark 51 skyscreen—Station 1.

Cameras (all at Station 1)—5-16 mm, 2-35 mm, 4 Theodolites, 1-35 mm Fastex, 3 CZR's, 1 IGOR 35 mm, 1-70 mm. ⌘

# Big Complex Taking Form for Atlas-Centaur

A MASSIVE SPACE vehicle complex will soon be completed at Cape Canaveral for the *Atlas-Centaur*, scheduled for test flight during the second half of this year.

The *Centaur* vehicle is being built and tested by Convair Division of General Dynamics.

The new Complex 36, being built for the Air Force Ballistic Missile Division, has a huge, 173-ft. service tower, as tall as a 17-story building. It rests on 16 heavy railroad-type wheels mounted on tracks and is moved to straddle the launch pad by a hydraulically powered rack and pinion system, contrasting with the electric motor propulsion systems used at other *Atlas* complexes. Central work platforms are enclosed on three sides for protection from the weather.

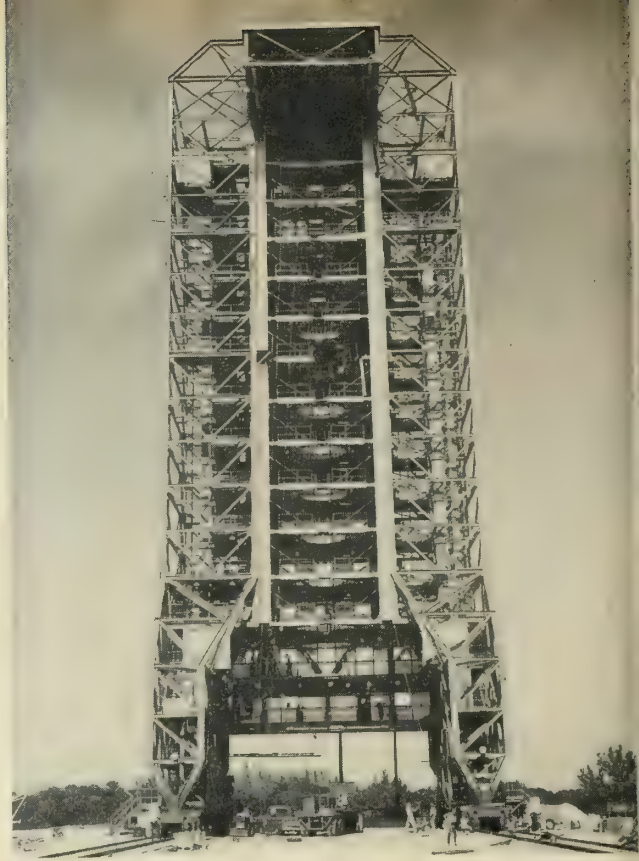
A permanent 70-ft. umbilical tower on the elevated launch pad is topped by two hydraulically retractable booms, which carry fuel, power and instrumentation lines to upper stages. The booms are withdrawn just before launch.

The launch and service building is built on two levels. This was done because additional space is needed to house unique servicing units, including a sophisticated fuel transfer system for *Centaur's* liquid hydrogen propellant.

The pad has a novel flame deflector, made of a special concrete construction that requires no water deluge for cooling during launch. Concrete was blown into place, to trap hundreds of tiny air bubbles for increased heat resistance. The flame bucket juts out at a 45° angle to divert exhaust heat from the gantry tower.

An above-ground cableway of walk-through design connects the blockhouse and the launch and service building. Technicians can make repairs in the tunnel-like passageway during countdown without exposing themselves.

The blockhouse, 75 ft. in diameter and 38½ ft. high, is built on two levels. The top level contains control consoles. Below is additional launch service equipment, as well as a complex crew ready room. The blockhouse is topped by a five-foot thick cover of reinforced concrete, topped by packed sand. Two-foot-thick doors close the entrance. ⁂



**ABOVE:** *Worker is barely visible (at right near top) on tower.*
**BELOW:** *Launch pad area as viewed from tower.*



# Superconducting Solenoids Advance

***Bell Labs use niobium-tin compound to create very high magnetic fields; applications seen in communications and plasma work***

RESEARCH SCIENTISTS at Bell Telephone Laboratories have now demonstrated the feasibility of superconducting solenoid magnets producing extremely high magnetic fields.

Using a superconducting compound of niobium and tin ($Nb_3Sn$), the experimenters measured steady-state magnetic fields of 88,000 gauss.

Indications are that the compound will sustain fields of 100,000 gauss or higher while carrying electrical currents of 100,000 amps per square centimeter of cross-section. Present facilities do not permit measurements over the 88,000 figure demonstrated.

Once the field is established, the superconducting solenoid does not require expenditure of electric energy; a solenoid of ordinary metal will use large amounts of energy.

It has been known for some time that it is possible to produce magnetic fields with superconducting solenoids. But materials tried in the past would sustain fields of only a few thousand gauss. At larger magnetic fields, the superconducting properties disappeared.

$Nb_3Sn$ becomes superconducting at 18°K, a higher transition temperature than that of any other superconductor known. This compound was first discovered at BTL in 1954, but its critical field had not been measured until now. Since the material is extremely brittle, it has not been possible to use it in constructing a coil magnet. Bell scientists had to develop new metallurgical techniques to overcome this problem.

• **Many uses**—BTL says the development will have important applications wherever large volumes of magnetic fields are required. One such application would be in the field of communications. Among the many electronic devices requiring magnetic fields for their operation are traveling wave tubes and masers. The availability of large magnetic fields can extend the operation of these devices to higher frequencies and provide the possibility of broadband communication systems for use in earth-based radio-relay systems and active satellite repeaters for space communications.

Another possible application is the containment of thermonuclear fusion plasmas for the production of electric power. Here, large volumes of high magnetic fields are required to provide a "magnetic bottle" to contain the high-temperature gas plasma.

In current concepts of such apparatus, one of the problems is that the power required to provide the magnetic containment uses a large fraction of the power produced by the nuclear fusion reaction and requires the construction of very large reactors. The use of superconducting solenoids with $Nb_3Sn$—which, in principle, will not require any power—will permit a much greater flexibility in the design and study of fusion reactors. Although power will be required to maintain the low temperatures necessary for the magnets' use, it is negligible compared to the power that a solenoid made from a conventional metal would use.

Another area where important application will exist is in the study of physical phenomena at high magnetic fields. In the past, the cost of producing high fields in the laboratory has greatly restricted scientific investigation. Only a few large laboratories have been able to afford the investment required. A large part of the cost of the instruments of nuclear physics such as accelerators and bubble chambers is expended in providing large volumes of high magnetic fields by conventional solenoid magnets.

A conventional magnet presently in operation at BTL requires a power supply and cooling equipment filling several rooms. In operation, it uses thousands of gallons of cooling water per hour and consumes 1.5 megawatts of electric power. By contrast, a superconducting solenoid magnet of $Nb_3Sn$, producing a comparable field, would consume virtually no electric energy once the flux is established. ❖



*SUPERCONDUCTING MAGNETIC COILS, contained in metal tube, are heated red-hot by radio-frequency induction furnace in vacuum jar. Coils are made from niobium tube filled with mixture of powdered niobium and tin and drawn to 0.015-in. diameter wire. When heated to 1000°C, the metals react to form $Nb_3Sn$ compound which has excellent superconducting properties in high magnetic fields.*

# Space Club Considers 90-ft. Rocket

***British and French would build first, second stages; third would be cooperative venture by 12 nations***

**by Anthony Vandyk**

STRASBOURG—A *Titan*-sized space rocket proposed by the British and French is up for adoption by Western Europe and interested governments have until March to decide "go or no go."

The proposal is for a three-stage liquid-fuel rocket the same length as the USAF 90 ft. *Titan*. The European satellite carrier would also have a first-stage diameter of 10 ft. It will cost an estimated $200 million to complete such a program, if it is supported by French and British state-of-art.

Britain has offered to pay one third of the cost. She offered her *Blue Streak* facilities and seemed to go along with France's offer to produce the second stage and a "continental" third stage. The twelve countries attending the Jan. 30 conference would be directly involved in the latter.

The first stage would essentially be the *Blue Streak*. The French second stage would have a gimbal-mounted motor and self-contained guidance. The motor would control pitch and yaw; "vernier" type jets were proposed for roll-control.

Velocity measuring devices to provide autopilot imput were part of the French offer. Fuel tanks would be vanadium steel, Vasajet 90. Suggested fuels were nitrogen tetroxide and UDMH.

• **Payload of 3150 lbs.**—British scientists pointed to advantages reaped from required research in advanced miniaturization, gyros and servo-studies. Europe would be called on to develop new fuels, lubricants and highly sophisticated manufacturing techniques in metallurgy.

The rocket, weighing in at 210,500 lbs. on the pad, would have an initial thrust of 274,000 and increasing to 300,000 lbs. upon acceleration. Spent first stage weight was given as 13,800 lbs.

Ambitious payload weights of 3150 lbs. and 1450 lbs. were discussed for orbital apogees of 300 miles and 5000 respectively. The British also made a bid for the third stage design by suggesting a four-chamber design pivoted about an axis.

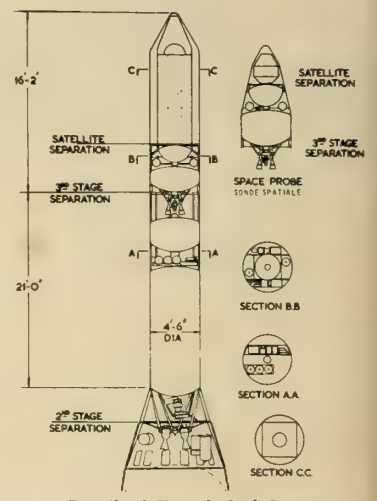
They claimed that a low-thrust-into-orbit last stage would have several advantages for last minute corrections in trajectory, particularly for communications experiments by the European group.

Arrangements for financing the space launcher organization were the subject of much lively discussion at Strasbourg. Finally it was proposed that because development of the *Blue Streak* is far advanced in Britain and because the bulk of the work would take place there, the United Kingdom would bear one-third of the cost of the $200 million program.

The share of other countries would be based on their national income except that those with smaller national incomes would contribute on a reduced scale.

France's contribution will be 14.4%; Germany's 13.2%; and Italy's 6.8%. It was proposed that Austria, Belgium, Denmark, the Netherlands, Norway, Spain, Sweden and Switzerland would each pay less than 3%. None of these smaller nations would have to pay more than $6 million for its participation in the European satellite launcher program. Australia would be offered free membership in the organization in return for the making available of its Woomera range and tracking facilities.

Immediate objective of the joint "Space Club" venture would be to put into orbit a communications satellite. Several proposals are under consideration, among them an active transmitter and receiver which would be orbitted at 22,000 miles above the equator, one at the 10,000 miles in and equatorial orbit and a third in a 5000-mile polar orbit. ¤




*Detail of French 2nd Stage*

## How Joint Space Effort Would Be Organized

*The structure of the proposed European satellite launcher organization has been disclosed.*

*At the top there would be a Policy Council or Board on which all participating nations would be represented. Its members would be fully authorized delegates, representing their countries and with authority to commit them. The business of the Board would be to settle policy (financial, technical and administrative) to agree to the time scales and where the work should go.*

*Then there would be an Executive Project Group to carry out the policy, place the contract, deal with procurement, ensure adequate resources for each part and the attachment of personnel from one country to another. Under, and responsible to, the Executive Project Group would be the chief technical authority—to be called the Coordinating Design Authority—which would survey the whole scheme and ensure that all parts, including ground equipment, were included in one coherent system. Under the Coordinating Design Authority there would be the local design authorities in charge of the different stages.*

*The lines of responsibility would flow upwards. The technical boards would be responsible in a technical sense for the whole project. The Executive Project Group would be responsible to the Policy Board for carrying out, within the time allowed, what the Policy Board had instructed to be developed.*



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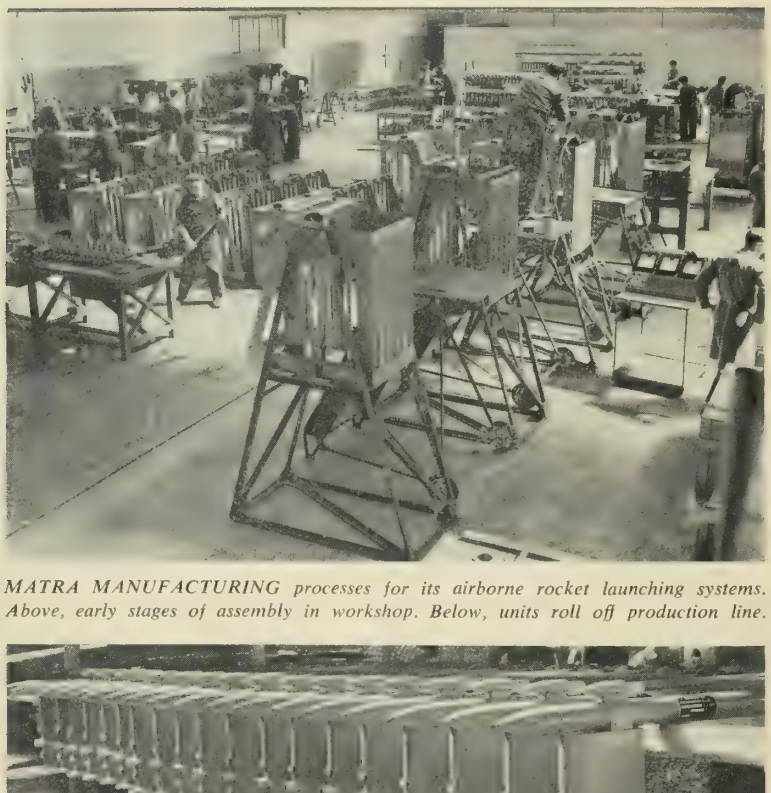
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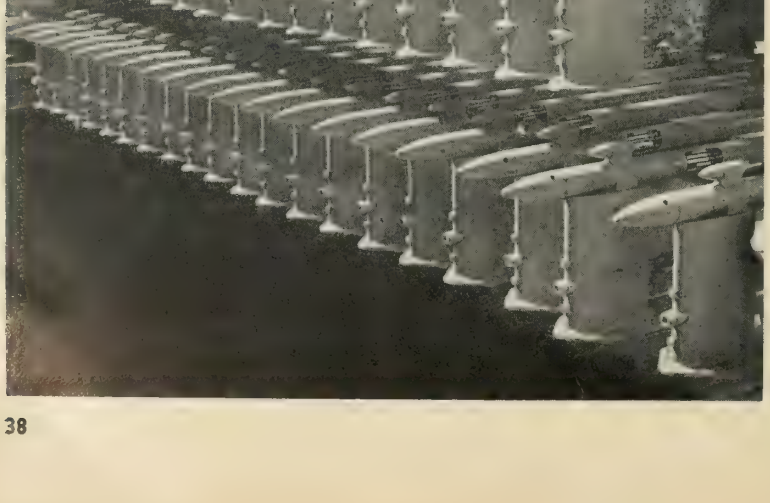
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# Two French Firms To Make Guided Birds

by Bernard Poirier



*MATRA MANUFACTURING processes for its airborne rocket launching systems. Above, early stages of assembly in workshop. Below, units roll off production line.*



MATRA AND Hotchkiss-Brandt who together provide practically all o France's airborne unguided rocket sys tems, are expanding their facilities t produce advanced guided missiles.

MATRA, which makes launcher for various SNEB rockets, has already displayed new infrared air-to-air mis siles and improved long-range surface to-surface systems. Sources close to th company indicated several other weap ons are under development.

Hotchkiss-Brandt, whose rockets ar identified as SNEB, has been the to supplier of unguided rockets to th French Air Force and has developed the solid motor for MATRA's radio guided *R 511*.

The Vautour fighter, for example carries the companies' system: up t 296 SNEB 68 mm rockets in MATRA pods—2 on each wing and 4 beneath the fuselage. The firing rate is 180 per minute. The pilot chooses the method of vollies depending on the target and mission.

There are several SNEB rockets the most popular selections being the 37 mm and 68 mm. Warheads include inert, impact and hollowcharge which are interchangeable on rocket cases in which more than one motor unit can be selected for use when loading.

A self-restrained safety arms the warhead after 120 ft. of flight. Slow arming is achieved by use of a wave shaped runner fitting a steel nipple on the inside of the motor casing. Pressure by the nipple along the runner walls slows the sliding arming device during initial acceleration.

The Hotchkiss-Brandt companys says its anti-armour fuzes detonatte within a 70° attack angle and will penetrate 280 mm armour plate. A troop-support ing attack at 300 mph results in strik dispersion of only 21/10,000 for rock ets launched from wing pods and 33/ 10,000 for fuselage pods.

MATRA, which employs 200 en gineers in applied research, has thre factories dotting the Paris area an a new plant at Salbris. The regula workforce number 1100.

Its plants produce airbone launc systems for over 26 foreign and Frenc aircraft. Recent best efforts by th company include the surface-to-a R 422B3.

Its newest offering is a promisin 530 (M/R Sept. 26, 1960, p, 43).

Australia may now adopt MATRA-Hotchkiss-Brandt attack sy tem since the R.A.A.F. picked th French Mirage III a few weeks ag as its all purpose attack/fighter in a overall modernization build-up i armaments. So far, the Aussies hav selected optional French equipment i cluding electronics compatible wit French missile systems.

## Venus the Unknown

(Continued from Page 14)

the facts known about Venus can be written without too much trouble on the back of an envelope.

It is believed that the depth of Venus' atmosphere from the planet's surface to the top of the visible cloud layer is 15 miles. Rand Corporation scientist S. H. Cole estimates its atmosphere to be: 90% carbon dioxide; 10% nitrogen; traces of argon; no water; and possibly some free oxygen. Surface barometric pressure is estimated to be of the order of ten atmospheres and the mean surface temperature higher than 150° F.

Disagreeing with Dole, the noted astronomers Fred Whipple and D. H. Menzel say there is plenty of water on Venus, the planet's entire surface being covered with it.

There's a third opinion. The eminent director of Georgetown University's Observatory, F. J. Heyden, S.J., says that his observations over the past several years have made him reasonably certain that there are significant quantities of nitrogen peroxide in Venus' atmosphere. If this is so, then such a noxious atmosphere would make life impossible. Neither would there be water on the planet because the liquid would react with the peroxide to form nitric acid.

"This is not necessarily so," says Texas University astronomy professor G. de Vaucouleurs, one of the most prolific writers about Venus and one of its most interested observers. He submits that in the earth's atmosphere there is about 3 mm of ozone, which is extremely destructive to life; but since the substance is high in the atmosphere, it does us no harm.

Apart from the details about its orbit, which have been known for a long time to a high degree of precision, the following Venus data are among the less controversial: minimum distance from the sun, 66.2 million miles; mean distance, 67.2 million miles; maximum distance, 68.0 million miles. Mass, compared to earth's, 0.8073 to 0.830. Diameter, to top of cloud layer, 7560 to 8740 miles. Obateness of spheroid, 0.00. Visual albedo, 0.59. Atmospheric composition, known to contain carbon dioxide.

In visible light, Venus looks like a slightly yellowish white sphere which has practically no features. Some observers reported seeing vague gray markings but they did not persist for long. More markings appear, still transiently, as the planet is viewed by the light of shorter wavelengths. Photographs taken in ultraviolet light show features described as clouds. ❖

# soviet affairs

by Dr. ALBERT PARRY

### The Soviet shot toward Venus

was one of the things-to-come predicted by that amazing Russian rocket pioneer Konstantin E. Tsiolkovsky. In my book published last November, *Russia's Rockets and Missiles,* I recalled Tsiolkovsky's "early proposal to use artificial satellites . . . as the jumping-off stages for Mars, Jupiter, Venus, and yet farther bodies" (page 335). Soviet Russians have honored Tsiolkovsky for such prophecies and suggestions among others from the very start of the modern space age. Typical was the article in *Pravda* of September 17, 1957, by Academician S. Korolev paying tribute to Tsiolkovsky on the occasion of the 100th anniversary of the latter's birth and particularly praising that pioneer's long-ago plans for "permanent space stations . . . to facilitate the flight of cosmic rockets to distant destinations."

### Schedules of Venus-bound rockets

were published in 1957 by Yuri S. Khlebtsevich, chairman of the Soviet Technical Committee on Radio-Television Guidance of Rockets, author of the so-called L-V-M timetable, showing a future agenda of rocket shoots not only Lunar but also to Venus and Mars. He envisaged a successful launching of an unmanned Soviet rocket to Venus sometime in the 1960s or 1970s. He said such a rocket would take only 146 days to reach Venus. But he added a feature, which apparently was not used in the Soviet shoot of February 12, 1961: After the third stage of this rocket would have orbited around the Earth for a while, *it would receive additional loads of fuel by ferry rockets from Earth,* and only then, on a Soviet signal from below, it would blow off for Venus. Khlebtsevich also included a plan for his Venus-bound rocket to begin sending television pictures back to Earth 24 hours before hitting Venus.

### Another Red prophet of rockets for Venus

was Yuri S. Kryuchkov, author of a 1958 booklet *Ships of Interplanetary Spaces,* published by DOSAAF, the Soviet Union's civilian defense organization. In his text Kryuchkov discussed the orbiting—rather than reaching—of Venus and Mars. He suggested, as something entirely feasible for the near future, man's orbiting of these two planets along elliptical trajectories (without landing). He wrote that man—Soviet man, that is—could soon build "such orbital ships that would circle eternally around the Earth along elliptical orbits calculated to cross the Mars and Venus orbits." Thus both Mars and Venus could be orbited by such rockets not once, but many, many times—and the same principle could in time be expanded to make circumnavigation of other, more distant planets quite practical.

### Possibility of life on Venus

was discussed by the late Professor Gavril A. Tikhov, director of the Alma-Ata Observatory in the Soviet Kazakhstan in Central Asia, who for many years until his recent death was in charge of the Astrobotany Sector of the Kazakh Academy of Sciences. On one occasion, writing in *Krasnaya Zvezda* (the chief daily of the Soviet armed forces), Tikhov remarked that man had some definite information about the upper strata of the atmosphere of Venus, but not about the lower strata. The Earth's astronomers and astrobotanists have noted the presence of much carbon dioxide, but neither oxygen nor water vapors, in the upper atmosphere of Venus, which circumstance did not, however, discourage Professor Tikhov. He speculated in *Krasnaya Zvezda:* "There may be little crystals of ice in the clouds enveloping Venus. Perhaps there are also water vapors and even oxygen in the lower strata of that planet's atmosphere inaccesible to our observation. And perhaps the great amount of the carbon dioxide in the upper atmosphere stems from the rich vegetation on Venus. If so, there must be animal life on Venus. In any case, to form carbon dioxide, there must be oxygen and carbon, these chief ingredients of plants and prerequisites for emergence of animal life. Thus, even though Venus is still an 'unsolved' planet, we have reasons to suppose that life does exist there."

# Weight of Surveyor Payload to Be Doubled

***Three-year program slated for speed-up to two-year schedule; JPL and Hughes scotch reports that third stage was being considered***

**by Frank G. McGuire**

PASADENA, CALIF.—Payload weight of the *Surveyor* lunar soft-landing vehicle is being doubled. Nuclear power supplies for the program also are now being considered, possibly for the first launch in the spring of 1963.

The original program spread of three years has been compressed into two years. These significant departures in the program parameters have occurred since NASA originally laid out the *Surveyor* program to industry four months ago (M/R, Nov. 7, p. 39).

Nuclear power supplies being developed for *Surveyor* are expected to be available in 1961. The radioisotope thermoelectric generator (RTG) would use a curium-242 source and supply about 15 watts of power.

Major parameters of the program were disclosed at a press briefing here, apparently to spike what some officials felt were "grossly inaccurate" reports published recently about the program. One speculated that there would be a third stage for the *Atlas-Centaur* booster, using a JPL liquid hydrogen rocket engine that was cancelled with the *Vega* program over a year ago.

Jet Propulsion Laboratory, technical director for the program, and Hughes Aircraft Co., developer of the *Surveyor* vehicles, said there was no intention of going to a third stage.

Hughes is developing the *Surveyor* spacecraft under a contract to be negotiated with JPL. Final cost is expected to exceed $50 million.

Dr. Leo Stoolman, *Surveyor* Project Manager for Hughes, told M/R that the most difficult part of the entire *Surveyor* program obviously is getting the vehicle safely on the moon in the first place. If this can be accomplished, he said, the design approach of using proven components and subsystems with strong emphasis on reliability will take care of the rest of the mission.

Although tests conducted by Hughes failed to show how the vehicle could possibly topple over on impact within any reasonable degree of landing attitude, the firm is building the vehicle so that it could perform a part of its mission even lying on its side.

Hughes won the *Surveyor* contract in December, after a competition involving North American Aviation, McDonnell Aircraft, and Space Technology Laboratories.

The original NASA schedule for the *Surveyor* program had it following the *Ranger* series of hard-landing vehicles in 1963. Seven *Surveyor* vehicles now are slated for launching by 1965, whereas the initial schedule went into 1966.

The *Surveyor* vehicle will weigh some 2500 lbs. upon injection into a lunar impact trajectory, and firing of its retro rocket before landing will reduce weight to 750 lbs., of which at least 200 lbs. will be instrumentation. Originally, weight of instruments to be soft-landed was estimated at about 100 lbs. It may be increased to 275 lbs., and possibly well over 300 lbs.

Depending on experiments to be carried out and the particular configuration used, final weight could go over 300 lbs. The inclusion of a radioisotope power supply would increase the weight a bit. If favorable calendaric conditions are coupled with the heavier vehicle configuration, weight of final payload may approach 375 lbs.

In all calculations on the program, JPL and Hughes have been very conservative, taking into account reliability, possible malfunctions, and other considerations. The official "over 200 lbs." figure for the payload is an example.

Maximum data transmission rate includes output from four television cameras, one having color capability, two transmitters, and other telecommunications gear.

All electronics will be solid state to as great an extent as possible. There will be no artificial lighting for the television cameras. Other telecommunications electronics will include two command receivers, a transponder, a command decoder, and various signal processors.

All equipment is designed to land at a rate of less than 10 fps, but is being built for a maximum unplanned impact exceeding 100 earth g-forces. Realistic maximum g-force expected is about 20 g's, however.

*Surveyor's* basic mission is to softly land its cargo on the moon at a predesignated site on the eastern half of the lunar disc, and maintain operation for at least 30 days, telemetering data back to earth.

In order to be visible from Goldstone Deep Space Instrumentation Facility, the vehicle is expected to arrive on the moon after a trajectory of about 66 hours.

Developmental risks in the vehicle components are being minimized through use of proven hardware and techniques wherever possible.

• **System design**—The basic *Surveyor* system consists of (1) a trajectory control system (2) a terminal descent control and landing system; (3) payload of TV and scientific instruments; (4) wideband telecommunications link

ith earth; and (5) power, manipula-
on and thermal control for equipment
peration.

Using the Deep Space Instrumenta-
on Facilities (DSIF) at Woomera,
ustralia and Krugersdrop, South
frica, JPL hopes to use a command
d data-handling console to maintain
ntact with the vehicle during its tran-
phase and while it rests on the moon.
is through the Goldstone DSIF that
PL will operate the radio command
ajectory control subsystem of *Sur-
yor.*

Hughes has incorporated six major
ements into the *Surveyor* vehicle:

–The basic vehicle, which will have
thermal control system and mechan-
ally-operated planar arrays for solar
lls and antennas. It will be designed
ith a low center of gravity and wide-
ance landing gear using three legs.

–The scientific payload and its ac-
mpanying manipulating equipment.

–An inertially stablized control sys-
m, backed up by celestial readings.
ne Sun and earth (or moon) will be
ed as reference points during the
ansit phase, while radar will give local
sition and velocity readout when the
hicle approaches the moon.

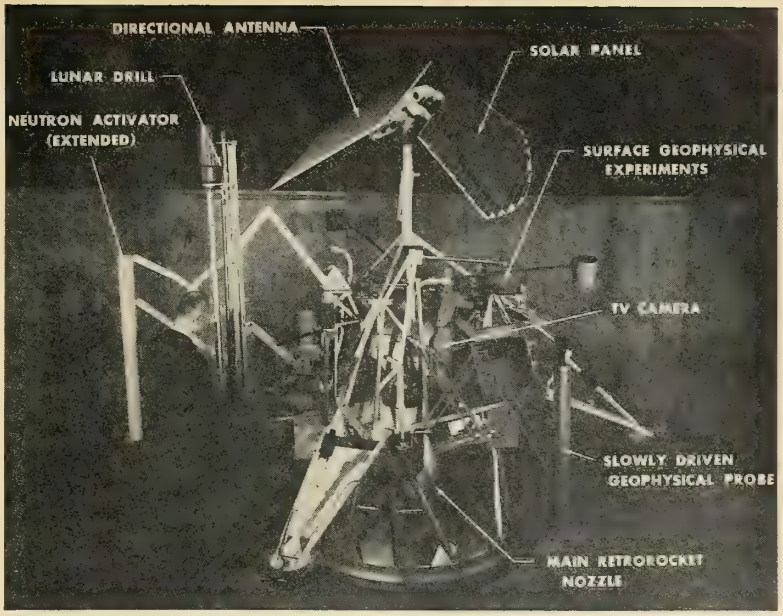
–A solid propellant rocket engine
ill provide main retro propulsion,
hile liquid propellant vernier engines
ill give control over thrust vector and
ill make mid-course corrections dur-
g the transit phase.

–Solar cells and battery power sup-
y, which may be either augmented
replaced by a radioisotope thermo-
ectric generator in some or all of the
ven vehicles.

–A telecommunications system, solid
ate, FM-type, using the high-gain an-
nna and an omnidirectional antenna.
ughes says the system will provide a
herent doppler transponse for DSIF
cking, command reception, and other
ecommunication functions.

• **Transit phase**—*Surveyor* will be
unched by *Atlas-Centaur* from the
lantic Missile Range. During its
ght to the moon, it will require one
d-course trajectory correction by its
rnier engine system, which is de-
ned to put the vehicle in a precise
ot on the moon. The retro rocket
ll counter the forward velocity as
uch as possible during descent, aim-
g at a landing speed of about ten fps,
the same as a man landing on earth
a parachute.

The establishment of nearly-zero
netic energy and an erect attitude
on landing will follow main retro
rnout at an altitude of approximately




*FULL-SCALE MODEL of the 11-ft.-tall Surveyor spacecraft. Hughes Aircraft Co. will build seven of the vehicles under technical direction of JPL.*

26,000 feet above the lunar surface.

Aside from the vernier engines, stability during flight can be supplied by two cold-gas jets controlled by gyro error signals.

After injection into its lunar trajectory, the *Surveyor* legs unfold and the omnidirectional antenna is extended on a signal from the *Centaur* computer. Reason is because, at this point, the vehicle is not within view of the Krugersdorp DSIF for command signals to be used. About fifteen minutes after injection is when the DSIF facilities may exercise command functions.

Approximately twenty hours after launch, the DSIF sends a command signal for trajectory correction, based on computed parameters for mission success. The signal given the *Surveyor* is based on attitude and velocity magnitude changes to be made, based on the known positions of the vehicle, the sun, the earth and the moon. The signal is transmitted by Goldstone DSIF by way of command and data console about fifteen minutes before the manuever is to take place.

The command receiver accepts the signal in terms of angle to roll, angle to pitch, and velocity to gain. This data is stored in a digital register and the earth and solar sensors are later overridden so that the vehicle may be programed around to the proper attitude. The vernier engines are then used to add the needed velocity.

About a half-hour before expected impact, the vehicle is aligned along the retro thrust axis with its high-gain antenna looking at earth. At this point, downward-looking TV camera number 4 begins transmitting one 600 by 600 line television frame per second.

The retro phase of the trajectory is expected to remove about 8800 fps from the total velocity of *Surveyor*, arriving at virtually zero velocity at the surface. The control system is designed to accommodate approach angles up to 45 degrees from the vertical, still assuring a right-side-up landing at less than ten fps. If the vehicle arrives at 25 fps error, it means an altitude error of 60 feet in the descent phase computation.

From a point five minutes before impact, all functions are automatic.

When the vehicle is 53 miles slant range from the surface, a trigger radar mounted in the exhaust nozzle of the retro rocket signals the rocket to fire. Since the radar has now performed its function, it is blown away by the rocket blast. Firing of this main retro is preceded slightly by ignition of the three vernier rockets for moment control.

Hughes estimates that about 12,000 feet altitude uncertainty exists at burnout of the solid propellant retro rocket due to various considerations in the descent. The vernier rockets will therefore supply any additional retro thrust required. A vertical doppler radar signal will control the verniers during this descent portion, and a touchdown switch will turn off the engines at impact.

Due to the extreme criticality of the retro phase of the operation, Hughes has placed 75% of the injected weight in the retro system. ⌗

## Details of Beanstalk Program Planning

(Continued from Page 18)

The first three launchings with payloads employing Phase I, stored message, configuration, contained a message consisting of two 30-second parts. The first part was made up of a carrier and tone sequence consisting of 1 sec. each of the following: (1) carrier with no modulation; (2) modulation at 1000 cps; (3) modulation at 1350 cps; and (4) modulation at 1750 cps. The sequence was repeated to fill a 30 second interval.

The second (voice) part of the message consisted of the following:

"SKY KING, SKY KING, THIS IS OXBOW. DO NOT ANSWER, DO NOT ANSWER. BREAK, BREAK. CANDY BOX X-RAY. AUTHENTICATION IS YANKEE. I SAY AGAIN, SKY KING, SKY KING, THIS IS OXBOW, DO NOT ANSWER, DO NOT ANSWER. BREAK, BREAK. CANDY BOX X-RAY. AUTHENTICATION IS YANKEE. OUT."

Once message transmission was initiated, the two parts were repeated alternately for the flight's duration. Telemetry was not employed because of the exceptionally short time schedule.

**Mission 1**—First PCC rocket was launched Jan. 14, 1960, with a Phase I payload. The carrier came on at approximately T-2 seconds. Modulation was programed to begin at T+58 seconds so the tape recorder would not operate during high-acceleration final stage *Sparrow* boost period between T+53 and T+55 seconds. Having the carrier on at lanuch was intended to facilitate tracking and doppler frequency measurements to measure velocity. Transmission terminated at approximately T+70 seconds.

**Mission 2**—Second PCC vehicle was launched February 16. Because it was believed that the short transmission period Mission 1 was caused by environmental conditions, the Mission 2 payload had been subjected to additional testing. One internal relay was removed and two others replaced with improved models. Basic payload functions and programing remained unchanged. Results were essentially as in Mission 1 except that weak and distorted signals of less than 1/100 watt were received at Boulder, Colo., station.

Mission 3 payload was modified to allow generation of a stepped radiated-power sequence. Steps included one period of virtually zero radiated power. By this technique, a corona discharge at the antenna initiated at any power level would certainly be extinguished during the zero power period. Because the rocket environment is continually changing, the probability of successively initiating antenna breakdown continually decreases.

To further minimize antenna breakdown, the timers were rearranged to delay start of r-f radiation until after 90 seconds of flight. In the absence of an ionized environment, the voltage required by a given antenna configuration to break down is a function of pressure. By delaying start of transmission it was hoped to obtain a margin of safety.

**Mission 3**—With a payload incorporating the above modifications, the third PCC rocket was launched March 16. The 90-second timer closed prematurely at *Sparrow* ignition, and the results were similar to Missions 1 and 2.

After poor results of the first three firings, it was decided to spend 90 days sudying the problem. As an additional safety factor, it was decided to incorporate a telemetry system.

Although antenna breakdown tests had not resulted in permanent payload damage, the fact that in all three flights signal loss began in the rocket's critical altitude range made additional testing essential.

• **Trouble located**—During a high-temperature test with the payload fully pressurized, a failure occurred at the joint between the nose cone and payload skin. Strength reduction of the magnesium alloy nose cone material at simulated flight temperatures, coupled with the force exerted on the nose cone by internal payload pressure, caused a permanent deformation in a nose cone bolt hole.

The following steps were then taken: (1) nose cone material was changed to aluminum for improved high-temperature strength characteristics, and material thickness was doubled; (2) nose cone/payload skin joint was reinforced with a stainless steel band; and (3) the number of securing bolts doubled.

Reliability was increased by employing a fused quartz insulator in the antenna assembly with a double "O" ring seal and a solid aluminum cone forward of the insulator. The antenna tip also was constructed of stainless steel.

**Mission 4**—The fourth PCC rocket was launched July 27. Modified payload included new nose cone, antenna and 15-lb. telemetry package. The rocket exploded at 15,000 ft.

**Mission 5**—The fifth PCC rocket was launched August 10 with a payload almost identical to flight four. The vehicle apparently functioned satisfactorily during flight. Apogee, reached at T+330 seconds, was estimated at 238 mi. Total flight time exceeded 610 seconds. There was no modulation, but signal strengths received at various monitoring sites were about as predicted.

**Mission 6**—The sixth PCC rocket was launched August 31. Payload was essentially as in fourth and fifth flights except that telemetry was eliminated. Due to rocket malfunction, apogee was only 30% of the predicted value. This reduced communication range but signal quality was excellent at all receiving stations within range.

One problem never completely solved during the program was determination of actual payload trajectory. When the tests took place, Eglin had no radar to skin-track *Sparrow* and payload portions. Sustainer stage was radar-tracked by means of a beacon in that stage. This provided an accurate determination of sustainer trajectory but not *Sparrow* and payload, which separated from the sustainer at about T+53.

Eglin also used phototheodolite tracking, but this was generally accepted as less accurate than radar. With proper conditions, *Sparrow* ignition time could be accurately determined from phototheodolite data, but no additional *Sparrow* payload information combination could be obtained.

Even the "normal" *Sparrow* burning, there was insufficient data to determine accurately re-entry attitude. Because drag and descent time after re-entry are extremely sensitive to vehicle attitude and configuration, path of the last 20 to 25 mi. of descent may be unrelated to computed trajectory. These factors did influence results observed during Mission 6, and may have influenced other missions had they not been eclipsed by more obvious problems.

• **Theory proven**—Results of *Tattletale* do not indicate difficulties limiting application of UHF communications between rocket-borne transmitters and remote airborne and ground receivers. Extension to higher altitudes, powers and ranges should not introduce new problems.

Communication ranges and received signal strengths agreed well with predictions from theory, considering rocket antenna patterns and estimated variations in rocket attitude. In most flights transmission ranges exceeded those which would be predicted from strict line-of-sight considerations. The conclusion was drawn from this that specifications for this type of system may be based upon conventional theoretical determinations as far as maximum range and signal strength are concerned.

# contracts

## NASA

**1,005,000—George A. Rutherford, Inc.,** for services, labor and materials for construction of Energy Conversion Laboratory at Lewis Research Center.

**575,000—General Electric's Flight Propulsion Laboratory Department,** Cincinnati, for study of heat flow characteristics of several working fluids which may be used in spacecraft nuclear power plants.

**44,087—Radio Corporation of America, Electron Tube Division,** Lancaster, Pa., for high-vacuum test chamber system for Lewis Research Center, Cleveland.

**27,294—Ryan Industries, Inc.,** Cleveland, for transportable cryogenic dewars for Lewis Research Center.

**22,900—Republican Aviation Corporation,** for investigation of the use of electrical discharge to form high-strength metals.

## MISCELLANEOUS

**250,000—General Electronic Control, Inc.,** for engineering services of *Titan* ICBM. Two contracts with **The Martin Company.**

**50,000—General Electronic Control, Inc.,** for manuals and engineering documentation on *Mace* missile. Subcontract from **General Motor's AC Spark Plug Division.**

## NAVY

**10,000,000—Westinghouse Electric Corporation,** Sunnyvale, Calif., for launching and handling equipment for five *Polaris*-carrying submarines.

**1,300,000—Military Electronic Computer Division of Burroughs Corporation,** for additional electronic computers for navigation systems in nuclear-powered submarines.

**1,200,000—Systron-Donner Corporation,** for inertial programing devices for production models of *Polaris* missile. Subcontract from **Missiles and Space Division of Lockheed Aircraft Corporation.**

**943,978—Vitro Laboratories,** for research and development facilities and personnel to perform research, analytical investigations, evaluation, design, fabrication of models and establishment of requirements for the development of *Typhon* missiles and *Typhon* missile components.

**336,900—Westinghouse Electric Corporation,** Washington, D.C., for research program for improvement of thermoelectric generator modules.

**99,745—Microwave Associates, Inc.,** Burlington, Mass., for study and theoretical analysis of high-power wave guide structures.

**33,382—Walker Electrical Company, Inc.,** Atlanta, for Missile Fire Control Switchboard *(Tartar).*

**6,381—Allied Pacific Manufacturing Co.,** Compton, Calif for gages for *Polaris* missile program.

**ubic Corporation,** San Diego, for AGAVE shipboard tracking systems. Amount undisclosed.

## ARMY

**,994,900—Western Electric Company,** New York City, for procurement of *Nike* replenishment spare parts (12 contracts).

**,476,839—Northrop Corporation's Nortronics Division,** for production of launchers for *Hawk* missile.

**$1,141,381—Aeronutronic Division of Ford Mortor Co.,** Santa Ana, Calif., for further R&D of *Shillelagh* missile system.

**$403,661—The Martin Company,** Orlando, for repair parts and/or modification kits for *Lacrosse* systems (3 contracts).

**$234,636—Douglas Aircraft Company,** Santa Monica, Calif., for procurement of *Nike* replenishment spare parts (2 contracts).

**$198,584—Electro-Mechanical Research, Inc.,** Sarasota, Fla., for ground telemetry station.

**$161,125—Daniel, Mann, Johnson & Mendenhall,** Los Angeles, for work on Phase II of Artrac.

**$32,284—University of Alabama,** for study of the capacity of the atmosphere and its radiation temperature.

**$30,000—Radioplane,** Van Nuys, Calif., for modification of drone system.

## AIR FORCE

**$6,500,000—General Dynamics Corp., Convair Division,** for technical data in support of *Atlas* missile airframe, components and related ground support equipment.

**$5,225,300—General Precision, Inc., Kearfott Division,** for follow-in production of precision rate integrating gyros for the *Atlas* missile. (Subcontract from **Convair.**)

**$1,808,000—Beckman Instruments, Inc., Systems Division, Anaheim, Calif.,** for electronic data processing equipment for use in Air Force satellite programs. Subcontract from **Lockheed's Missiles and Space Division.**

**$1,808,000—Systems Division of Beckman Instruments, Inc.,** for electronic data processing equipment for use in AF satellite programs. (Subcontract from **Lockheed MSVD.**

**$400,000—Land-Air, Inc.'s Cheyenne Division,** for engineering and design services in connection with the *Titan* missile.

**$260,675—Boeing Airplane Co.,** Seattle, for technical data applicable to the *IM-99B* missile.

**$229,696—General Electric Company,** for continuation of investigations already in progress analyzing the uses of ion-beam projectors.

**$229,686—General Electric's Technical Military Planning Operation,** Santa Barbara, Calif., for analyzing the feasibility of using ion-beam projectors (ray guns) as defense weapons.

**$200,000—The Bendix Corp.,** Ann Arbor, Mich., for engineering services for investigation of the state of the art in the design of radiation tolerant electronic devices/components.

**Espey Mfg. & Electronics Corp., Saratoga Industries Div.,** Saratoga Springs., N.Y., has received orders from the Martin Company for 43 battery charger power supply units for use in *Titan* ICBM program. Amount not disclosed.

**Lockheed Missiles and Space Division,** for study program on versatile automatic test equipment used for depot check-out of inertial guidance subsystems for Air Force missiles. Amount not disclosed.

**The Firestone Tire & Rubber Co.,** for continuation of an elastomer research program. Amount not disclosed.

# reviews

D.O.D. PATENT POLICY AT THE CROSSROADS: AN ARGUMENT FOR THE RETENTION OF TRADITIONAL INCENTIVES; A. J. Keeffe and D. M. Lewis, THE CATHOLIC UNIVERSITY LAW REVIEW, Vol. X, No. 1, January, 1961. $2.

The authors take the position that the Defense Department's policy of retaining a royalty-free license while leaving patent title to industry meets the Constitutional intent of promoting "the Progress of Science and the Useful Arts."

On the other side of the fence are the current policies of NASA and the AEC which take title for the government in any patent filed as a result of a government contract.

The authors dismiss the contention that the DOD method allows certain companies advantageous commercial patent monopolies, because, they say, any abuses can be handled under the anti-trust laws without disturbing a well-ordered patent policy at procurement levels.

In the matter of public funds underwriting industrial patents, Keeffe and Lewis argue that the public is not paying "twice for inventions under a license policy" because, in reality, these funds pay for the royalty-free license retained by government.

The authors treat several other aspects of this question, down to the position of a wholly "captive" government contractor. Then they point out the obvious difficulties in adopting the Mitchell Subcommittee middle-ground approach.

Keeffe and Lewis conclude by supporting the DOD policy as it now stands against the suggested reforms on the grounds that the arguments for change are "not so persuasive, or irrefutable as to justify the risks which will accompany a change."

They admit the need for reform but state that the final direction should become more apparent as other government agencies analyze the DOD approach.

The authors are realistic in mentioning that patriotic devotion might not be enough to take up the slack left after removing some of the incentives.

CLASSICAL MECHANICS, H. C. Corben and Philip Stehle, John Wiley & Sons, New York, 389 pp.

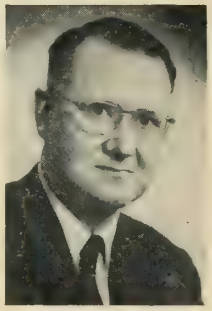
Here is the second edition of an already well-accepted book, now 10 years old. Much of the former edition has been rewritten to accent some of the more modern problems of the 1960's. For example, applications of the theory have been made to problems in space-charge limited currents, atmospheric drag, the motion of meteoric dust, variational principles in rocket motion, transfer functions, and dissipative systems.

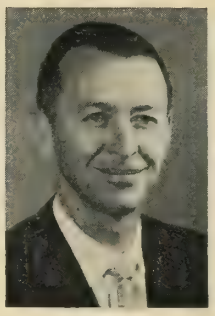
The book falls naturally into two parts: the development and use of Lagrange's equations, and the development and use of transformation theory. This treatment is said to make the relationship with quantum theory clear while the text remains thoroughly classical.

# names in the news


LIETZ


TYMINSKI


ISBISTER


PLUMMER


SMITH

**O. B. (Bill) Lloyd:** Press aide to Vice President Johnson and a one-time public relations man on the Consolidated Vultee Aircraft (predecessor to Convair) account, to be director of public information under NASA Administrator **James E. Webb.** Lloyd, 45, spent 15 years with United Press before joining Johnson's staff two years ago.

**General Phillips W. Smith:** President of Jack & Heintz, Cleveland, a division of The Siegler Corporation, Los Angeles, named a vice president of Siegler.

**James W. Plummer** and **Walter V. Tyminski:** Appointed Deputy Directors of Special and Military Satellite Programs, respectively, of Lockheed Aircraft Corporation. Programs include projects such as *Discoverer,* satellite work for NASA, *Midas* and other classified military programs.

**Eric J. Isbister:** Appointed Vice President-Engineering of Radiation, Inc., was formerly chief engineer of Sperry Gyroscope's Surface Armament Division.

**Arnold R. Lietz:** Former engineer on the *Redstone* and *Jupiter* missile programs, Chrysler Corp., appointed assistant general manager and manager of the Florida Division of Electro-Mechanical Systems, Inc., Titusville, Fla.

**William C. Foster:** Elected chairman of the board of trustees of Aerospace Corporation, succeeding **Roswell L. Gilpatric,** recently appointed deputy secretary of defense. Foster also is VP-senior advisor and director of Olin Mathieson Chemical Corp., board chairman of Porter International Co. and a director of several other organizations. Was a member of the organizing committee for Aerospace.

**Dr. Harold Brown:** Director of the University of California Lawrence Radiation Laboratory, elected to the board of trustees to replace **Dr. Chalmers W. Sherwin,** former Air Force chief scientist who continues as VP and general manager of the Aerospace Laboratories division.

**Harold D. Germann:** Former sales representative in the aircraft and missile fields for the Budd Company, appointed Manager of Government Operations for Thiokol's West Coast District Office.

**Isaac L. Auerbach:** President and Technical Director of Philadelphia's Auerbach Electronics Corporation, given special award by Philadelphia Section of the Institute of Radio Engineers for "his personal contributions, stimulation, and leadership in the international exchange of information in the electronic computer field."

**L. J. Adams** and **Robert S. Williams:** appointed directors of the *Titan I* and *Titan II* programs, respectively, for The Martin Company. Formerly, Adams was manager of the Martin-Denver Aeronautics Department and Williams was manager of the management information department for Martin-Denver.

**L. Eugene Root** and **Willis M. Hawkins,** corporate group vice president and vice president and missile division assistant general manager, respectively, of the Lockheed Missiles and Space Division, were presented the Navy Distinguished Public Service Award for their *Polaris* contributions. The Division received the Navy Certificate of Merit. The Navy Meritorious Public Service Award went to **Herschel J. Brown,** company vice president and general manager of LMSD; **Stanley W. Burriss,** *Polaris* system manager; **Frank J. Bednarz,** assistant director of research, and **Dr. Derald A. Stuart,** propulsion engineer.

**Dr. Richard B. Kershner:** Presented the Navy's Distinguished Public Service Award for organizing and directing the *Polaris* progress evaluation program at the Applied Physics Laboratory of Johns Hopkins University. The laboratory, active in the *Polaris* program for three years, was given the Navy's Certificate of Merit.

**Gilbert F. Roswell:** Former executive of the Leach Corp. firm, elected president of Fairco Industries.

**John L. Hill:** Vice President and Director of Hill Richards & Co., Inc., elected to the Board of Directors of Greer Hydraulics, Inc.

**Dr. Lewis R. Koller:** appointed research associate, and **Dr. Dilip K. Das** appointed project manager, at National Research Corporation.

**A. L. Lisle:** Named General Manager of Control Dynamics Corporation, formerly was with Kearfott Division of General Precision, Inc.

**Frank G. Compton:** Appointed to the newly created position of plans and marketing director of North American Aviation's Space and Information Systems Division.

**Albert P. Albrecht:** Former chief engineer at Gilfillan Bros., Inc., elected as vice president and general manager of Space Electronics division of Space Electronics Corporation, Glendale, Calif.

**William Perzley:** Director of engineering at Consolidated Avionics Corporation named a vice president of the company, a member of the Condec Group on industries.

**R. S. Bowditch:** Appointed chief engineer of the Electronics Division of Statham Instruments, Inc., was formerly general manager and chief engineer for ERA Pacific.

**Walter H. Powell:** Vice President of Operations of International Resistance Company, elected to the Board of Directors.

**John J. Landers:** Former manager of Quality Control at the Ordnance Department of General Electric Company, Pittsfield, Mass., named manager of Product Sales for Gyroscopes for the Precision Products Department of Nortronics, a division of Northrop Corporation.

**E. D. Carter:** Named corporate director of materiel and procurement, a new position at The Martin Co. Previously held a similar position at the company's Baltimore Division. Carter is also a member of the Senate Military Procurement Advisory Committee, and serves on other advisory panels.



## Dynamic Power Supply Analyzer

Static and dynamic output regulation and impedance measurements of regulated and unregulated power supplies can be made by an electronic Dynamic Power Supply Analyzer PSA-100 manufactured by Computer Sciences, Inc.

PSA-100 is a powerful tool for rapid analysis of breadboard supplies and production units. Dynamic impedance of the supply under test may be measured at frequencies from ½ cps to 150 Kcps. Testing of power supplies from 28 VDC to 250 at levels up to 1 amp can also be performed. The Power Supply Analyzer is completely isolated from the line and may be used to test positive or negative supplies. Testing levels up to 400 VDC may be obtained with Model PSA-101.

Circle No. 225 on Subscriber Service Card.

## Strain Gage Accelerometer

Low cross axis response, minimum damping change with temperature, and high resonant frequency are the significant features of Type 4-203 Strain Gage Accelerometer available from Consolidated Electrodynamics Corp.

Designed to measure accelerations parallel to mounting surfaces, the instrument is available in ranges from 5 g to ±500 g. Operable temperature range is −70°F to 300°F. Sensitivity to acceleration perpendicular to the sensitive axis is less than 0.01 g/g.

Damping is 0.7±0.1 of critical at 7°F. Combined linearity and hysteresis of the 4-203 is conservatively rated at less than ±.75% of full range output.

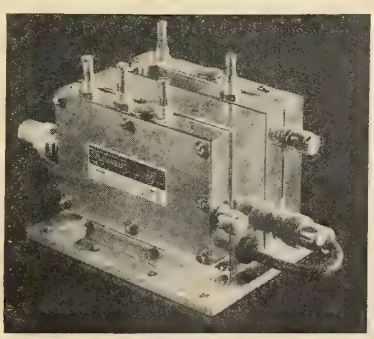
Circle No. 226 on Subscriber Service Card.

## Varactor Multiplier

A high-power varactor multiplier that uses printed strip transmission line resonators at the low frequency of 150 mc is available from Micromega Corp.

Performance characteristics of the solid state unit are: input frequency, tunable from 145 to 165 mc; output frequency, tunable from 870 to 990 mc; output bandwidth, 30 mc; multiplication factor, 3 x 2 = 6; conversion efficiency @ 2w input, −7db @ −20db spurious output and −8db @ −60db spurious output; maximum input power, 2w; operating temperature range, −50° C. to +75° C.

Circle No. 227 on Subscriber Service Card.



## Digital Arithmetic Center

Clary Corp. is marketing an off-the-shelf digital arithmetic center. Model DAC-2500 is a solid state component for computing, process control, instrumentation and test systems.

Flexible input and output control circuits allow a full range of peripheral equipment to be easily connected with the center. These include punched card and punched tape units, analog-to-digital converters, digital voltmeters, X-Y plotters and printers.

Circle No. 228 on Subscriber Service Card.

## Tiny Instrumentation Recorder

A 3-channel instrumentation quality magnetic tape recorder, measuring only 2 by 4 by 5 in. and weighing only 31 oz. (including 7 oz. of tape), has been introduced by Precision Instrument Co. Designed for direct recording of dynamic data in the range from 100 cycles to 5000 cycles, the recorder is capable of operating in any environment where man can exist.



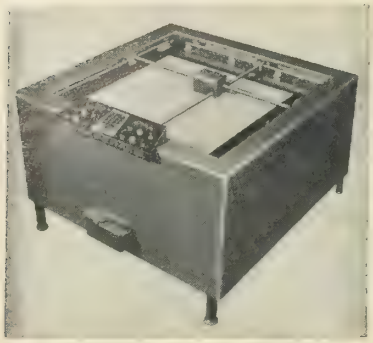
In addition to recording dynamic data in voice frequency ranges, the PS-303M can also be used in conjunction with standard IRIG telemetry subcarrier oscillator equipment for multiplexing up to 30 channels of data in the range from d-c to approximately 100 cps.

Circle No. 229 on Subscriber Service Card.

## Solid-State Plotter

A 30 x 30 in. X-Y Plotter, accurate to .05% of full scale and repeats exactly from any direction is being marketed by The Gerber Scientific Instrument Co.

The solid-state plotter eliminates

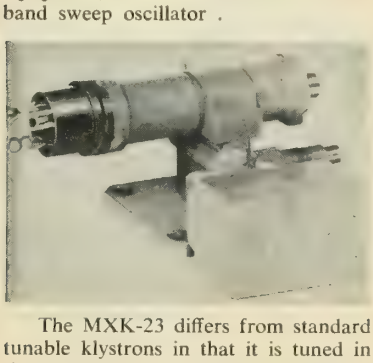


servomechanisms and input can be from IBM cards, punched paper tape or keyboard. Slewing speed is up to 20 in. per second. The printing head contains twelve symbols, any of which can be selected at random; other print sectors can also be added to plot digital as well as symbol information.

Circle No. 230 on Subscriber Service Card.

## 400 MC Range Klystron

Metcom, Inc. has available a MXK-23 klystron, electrically reflex klystron with a tuning range greater than 400 megacycles. It is for use in the X-band region, in radar equipment and test equipment, as local oscillator or as wide band sweep oscillator .



The MXK-23 differs from standard tunable klystrons in that it is tuned in the conventional mechanical manner and is electronically tuned for 400 mc. from any mechanical setting. The electrical tuning feature affords the advantage of more simplified circuitry, while the easy, rapid tuning makes it ideal for AFC circuitry.

Circle No. 231 on Subscriber Service Card.

## Varactor Diodes

Tyco Semiconductor Corp. is marketing a series of gallium arsenide varactor diodes. The series of six varactor diodes, designated the AP-1 series, range in cut-off frequencies from 60 to 150 KMC minimum at an operating bias of –2 volts measured at 10 KMC.

The AP-1 series has a (cw) power dissipation rating of 150 mw at 25°C measured at 10 KMC and a breakdown voltage rating of 6 volts for a reverse current of 10 ua at this temperature.

Circle No. 232 on Subscriber Service Card.

## Adjustable Motor Bases

Speed Selector Inc. has available a line of adjustable motor bases in two models, MB-11 and MB-12. These adjustable motor bases may be used with Speed Selector standard M-type spring-loaded sheaves to provide a complete drive for low-speed applications in horsepower capacities from ¾ hp. to 10 hp.



Speed variation is accomplished by a simple handwheel control as illustrated, but remote control can be provided if desired. The versatile design of these motor bases permits their use in an angular position. This maintains proper belt alignment and assures longer belt life.

Circle No. 233 on Subscriber Service Card.

## Image Converter Camera

An Image Converter Camera, available in April from Space Technology Laboratories, Inc. is described as the only complete diagnostic tool for instrumentation of high speed luminous transient events encountered in plasma physics, chemical kinetics and hypervelocity experiments.

It is capable of taking framed photographs at exposure times varying from three millimicroseconds to 200 millimicroseconds. Three-picture series can be made at rates of half a million to twenty million exposures per second. Streak photographs may be taken at writing speeds of four to 1000 millimeters per microsecond.

The unusual performance of the camera is made possible by converting the optical image to an electron image which allows electronic shuttering, light amplification and image deflection.

Circle No. 234 on Subscriber Service Card.

## Silicon Epitaxial Transistors

Texas Instruments, Inc. has available two ultra-fast switching transistors mass produced by the epitaxial manufacturing process. Typical switching characteristics of the TI 2N743 in a saturated circuit are 26 nanoseconds total switching time at 10 ma and 24 nano-seconds at 100 ma. The 2N744 highlights typical total switching times of 27 nsec at 10 ma and 29 nsec at 100 ma.

Circle No. 235 on Subscriber Service Card.

## Electroexplosive Device System

An electroexplosive device system tester is available from REDEL Inc. With appropriate accessories the parameters important for the determination of the RF hazards such as capacitance, Q, and inductance of EEDs can be readily measured also.

The Redel EED System Tester determines those frequencies representing maximum and minimum susceptability of unwanted RF initiation. It determines without expensive field testing that RF environment which will be hazardous, and provides accurate check of the influence upon RF susceptibility of geometrical changes in EED System

Circle No. 236 on Subscriber Service Card.

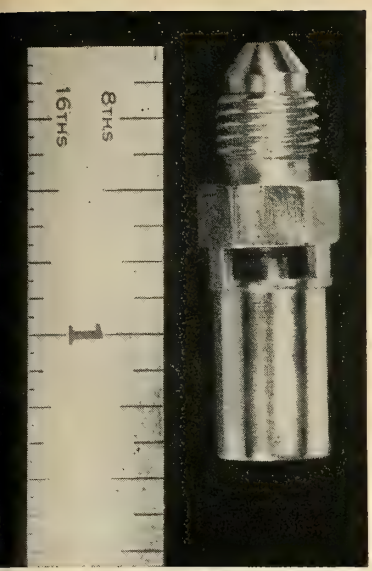
## Hazardous Gas Detector

The Model 520 Multitector avail able from Houston Instrument Corp provides a central control housing fo multi-point monitoring of the presenc and concentration of hazardous, com bustible gases at varying locations. De tection is performed by sensing ele ments located at the desired points o areas and connected to the central uni by cables which can be up to 1500 fee long. Each detection point has its ow measuring circuit, indicator and adjust able alarm and is referred to as channel. Up to 5 channels may b supplied for any unit which encom passes a control power supply an audible alarm and is available in rac mounting or case enclosure.

Circle No. 237 on Subscriber Service Card.

## Hot Gas Relief Valve

A hot gas pressure relief valve fo liquid and solid fuel exhaust system has been developed by General Pneu matics incorporating a replaceabl metal seat which is pressure tight u to 2000°F.



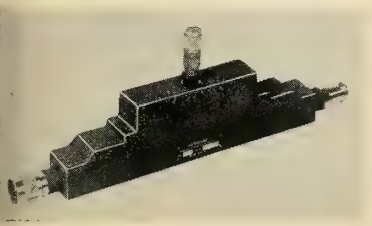

A typical design cracks, permits full flow, and reseats all within 50 PSI in 1000 PSI—2000°F exhaust system.

Modifications have been successfully tested for airborne closed cycle refrigeration systems, and other specific operational and dimensional requirements.

Circle No. 238 on Subscriber Service Card.

## Coaxial Attenuator

A high power coaxial attenuator is available from Merrimac Research and Development, Inc. Fully tested in the field, this device continuously withstands 100 watts of CW power for 24 hours with no change in performance characteristics.



The attenuator offers zero insertion loss and provides up to 60 db of attenuation in the 300-5000 mc frequency range.

Circle No. 239 on Subscriber Service Card.

## Miniature Pulse Generator

A pulse generator, designated the Steinwood Tri-Pulse Generator, is available from the Harwood Co.

Specifically designed to provide a common time base for guidance of data reduction personnel, the generator feeds 10, 100, or 1000 pulses per second to as many as ten cameras or telemetering stations.

Weighing less than 1½ pounds the miniature 30-volt battery-powered generator has performed within 1% of selected frequency under the severe environmental conditions of sled runs exceeding 40 G's.

Circle No. 240 on Subscriber Service Card.

## Primary Standard Manometer

A double cistern nulling manometer providing the highest accuracy for a primary standard in pressure measurement is available from Ideal-Aerosmith.

The principle of the manometer, model #10-21-33, is identical to a U-tube manometer with the major refinement being the use of a large bore head on each leg—connected by a flexible passage—to facilitate reading to close limits and to make capillary depression error negligible. Total range of the manometer is 33 in., measuring either absolute or differential and capable of operating in a system where static pressure may be as much as 150 psi.

Circle No. 241 on Subscriber Service Card.

# new literature

BERYLLIUM COPPER STRIP—Beryllium Corp. has published a bulletin, No. S-1100-A, on Beryllium copper strip products. The bulletin describes the many advantages of using beryllium copper, gives physical and mechanical properties, and tells how to select the right beryllium copper alloy to meet specification requirements. Five alloys are presented in easy to use tabular form with complete data on properties before and after heat treatment. Also provided are properties in annealed, quarter hard, half hard, and hard state.

Circle No. 200 on Subscriber Service Card.

RCA SILICON POWER TRANSISTORS—An Application Guide published by R.C.A. describes the special features and use of 16 RCA medium-power, intermediate-power, and high-power silicon transistors. The Guide discusses construction details, voltage ratings, conditions for thermal stability, and equivalent circuits for these transistors. It also gives design procedures, specific design equations, and performance data for some of the most important circuits using these transistors.

Circle No. 201 on Subscriber Service Card.

OPTICAL-MASER—A booklet describing the theory and design of the recently announced solid state optical maser is available from Bell Telephone Laboratories, Inc. An optical maser is a device which produces a narrow beam of coherent light. In coherent light, all the waves possess a definite phase relationship to each other. It is this property in radio waves which makes it possible to modulate, direct, and control them, and to use them in communications. Because of the tremendously high frequencies of light, vastly increased amounts of information could be carried on a coherent light beam.

Circle No. 202 on Subscriber Service Card.

CONNECTORS—A miniature connector catalog has just been announced by the Electronics Division of DeJur-Amsco Corp. Complete description, illustrations, electrical and mechanical specifications, dimensional drawings, and ordering information are included in the catalog.

Circle No. 203 on Subscriber Service Card.

RECTIFIER CHARTS—Two convenient, time-saving wall charts have been prepared by the General Electric Co. to assist in the selection of optimum silicon and germanium rectifier components for basic circuits. By using one or both of these charts a circuit designer should be able to choose the right device more economically and without the time consuming reference to specification sheets and other information sources.

Circle No. 204 on Subscriber Service Card.

HYDRAULIC VALVES—An introductory brochure has been released by the Arizona Division of IMC Magnetics Corp. which covers product information on its line of hydraulic & pneumatic valves, rotary pressure switches, precision filters, hydraulic cylinders, & fuel atomizers. The brochure details such specific items as lap fit valves with 0.00002 in. clearance, filters with mesh sizes down to 5 microns, & atomizers with flow ranges from low flows of 8 lb/hr. to high flows of 300 lb/hr.

Circle No. 205 on Subscriber Service Card.

INVESTMENT CASTING—An illustrated comprehensive report on the characteristics, metallurgy, markets and future trends of the American investment casting industry is available from WaiMet Alloys Co. Subjects discussed in the report include: American investment casting industry statistics, activity of the Investment Casting Institute, important developments in investment casting alloys, properties and heat treatment of 17-4PH and AM-355 precipitation hardenable stainless steel alloys, recent developments in vacuum melting and advantages of investment castings over forgings for gas turbine vanes and blades.

Circle No. 206 on Subscriber Service Card.

## —when and where—

### FEBRUARY

**American Institute of Chemical Engineers, National Meeting,** Roosevelt Hotel, New Orleans, Feb. 26-Mar. 1.

**Pacific Electronic Trade Show, Great Western Exhibit Center,** Los Angeles, Feb. 26-Mar. 1.

**Armed Forces Management Association, Annual National Conference,** Shoreham Hotel, Washington, D.C., Feb. 28-Mar. 2.

**Association of Iron and Steel Engineers,** Los Angeles, Feb. 28-Mar. 2.

### MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.

**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

**Eleventh Annual Instrument Society of America Conference,** Roosevelt Hotel, Pittsburgh, Mar. 8-10.

**Second Symposium on Engineering Aspects of Magneto-Hydrodynamics, University of Pennsylvania, IRE, AIEE, IAD,** University Museum, Philadelphia, Mar. 9-10.

**Institute of the Aeronautical Sciences, Flight Propulsion Meeting,** (classified) Cleveland, Mar. 9-10.

**American Rocket Society, Test Operations and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

**American Society of Mechanical Engineers, Aviation Conference,** Statler Hotel, Buffalo, N.Y., Mar. 13-17.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

**Inter-Station Supersonic Track Conference, Sixth Supersonic Track Symposium,** (confidential), U.S. Naval Ordnance Test Station, China Lake, Calif., Mar. 14-16.

**Fifth National Conference on Aviation/-Space Education,** Mayflower Hotel, Washington, D.C., Mar. 16-18.

**American Congress on Surveying and Mapping and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 19-25.

**IRE International Convention,** Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 20-23.

**American Society for Metals, 12th Western Metal Congress,** Ambassador Hotel, and **Western Metal Exposition,** Pan-Pacific Auditorium, Los Angeles, Mar. 20-24.

**23rd Annual American Power Conference,** Sherman Hotel, Chicago, Mar. 21-23.

**American Meteorological Society, General Meeting,** Chicago, Mar. 21-23.

**American Chemical Society, 139th National Meeting,** St. Louis, Mar. 21-30.

**Fourth Symposium on Temperature, Its Measurement and Control in Science and Industry, sponsored by Instrument Society of America, American Institute of Physics, National Bureau of Standards,** Veteran's Memorial Hall and Deshler Hilton Hotel, Columbus, Ohio, Mar. 27-31.

**American Nuclear Society, Nucleonics in Flight Symposium,** Statler Hilton Hotel, Dallas, Mar. 28-29.

**Society of Aerospace Material and Process Engineers, Filament Winding Symposium,** Huntington-Sheraton Hotel, Pasadena, Mar. 28-30.

### APRIL

**International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Institute of the Aerospace Sciences, AFOSR, ONR, U.S. Army Signal Corps,** Auditorium of the Engineering Societies Bldg., New York City, April 4-6.

**American Rocket Society, Lifting Re-entry Vehicles: Structures, Materials and Design,** Palm Springs, Calif., April 4-7.

**Society of Automotive Engineers, 1961 National Aeronautic Meeting,** New York City, April 4-7.


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## Advertisers' Index


American Machine & Foundry Co.-Government Products Group ..... 19
Agency—Cunningham & Walsh, Inc.

Arcturus Mfg. Co. ..... 51
Agency—Anderson-McConnell Adv. Agency, Inc.

Avco Corp., Research & Advanced Development Div. . 12
Agency—Benton & Bowles, Inc.

Calco Mfg. Co. ..... 6
Agency—Kreicker & Meloan, Inc.

Fenn Mfg. Co. ..... 7
Agency—The F. W. Prelle Co.

B. F. Goodrich Aviation Products Co. ..... 20
Agency—The Griswold-Eshelman Co.

Government Products Group-American Machine & Foundry Co. ..... 19
Agency—Cunningham & Walsh, Inc.

Librascope Div., General Precision, Inc. ..... 2
Agency—Compton Adv., Inc.

Marquardt Corp., The .....10, 11
Agency—Grant Adv., Inc.

Minnesota Mining & Mfg. Co. 3
Agency—Batten, Barton, Durstine & Osborn, Inc.

Space & Information Systems Div. of North American Aviation, Inc. ..... 31
Agency—Batten, Barton, Durstine & Orsborn, Inc.

System Development Corp. .. 8
Agency—Fuller & Smith & Ross, Inc.

United Aircraft-Norden (Ketay) Div. ..... 4
Agency—Wilshon, Haight & Welch, Inc., Adv.

Varian Assoc., Radiation Div. 52
Agency—Hoefer, Dieterich, & Brown, Inc.


### EMPLOYMENT


Experiment, Inc. ..... 48
Agency—Eastern Adv., Inc.

General Electric Co., Ordnance Dept. ..... 49
Agency—Deutsch & Shea, Inc.



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*(of the Defense Electronics Division)*

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100 Plastics Avenue—Pittsfield, Massachusetts

# Earth Is for Peaceful Purposes

FOR LONG, COSTLY YEARS, the Eisenhower Administration kept the military out of space. Space, it was proclaimed, is for peaceful purposes.

We feel the emphasis was all wrong. We would like to suggest a new slogan for the Kennedy Administration: Earth is for peaceful purposes.

The best way to keep it that way is to acknowledge as rapidly as possible that the military has not one, but many missions to fill in space. If wars are going to be fought, we would just as soon have them fought in space, not on earth.

Throughout our history, military requirements have pushed technological development at a rapid pace. Certainly, we cannot afford at this time to do without that push. At this very moment, a Russian space probe is hurtling toward the planet Venus. The first U.S. attempt to reach Venus is not scheduled until next year. While there has been much ado in Washington recently about the Missile Gap, the Russians have made it quite plain that there is a Space Gap of considerable width.

You can be sure the Soviet Union is not making a fine distinction between its military and civilian scientific efforts. The Space Gap is as much of a threat to us as the Missile Gap.

This does not mean space should be an exclusive preserve of the military. It's a big place. There is room for the military, for the National Aeronautics and Space Administration and for private industrial effort. Wasteful duplication should be avoided.

BUT THE TIME HAS COME to declare loudly and firmly that there is no ceiling on our military effort. It is equally plain that the service which should fill the major role is the Air Force. Manned military operations in space are a logical extension of manned military operations in the atmosphere.

Programs such as *Dyna-Soar* and *Aero Space Plane* should be accelerated immediately. These will lead to manned space planes which can take off, carry out assigned missions and return to earth. We promise to burn the first letter we receive telling us this can be accomplished from an aircraft carrier.

Funding of Air Force space programs should receive full attention in the defense review now under way.

We suspect, incidentally, that when the Air Force has this space capability, it finally will be able to admit that intercontinental ballistic missiles really are artillery and give them back to the Army.

**William J. Coughlin**



**Arcturus**
MANUFACTURING CORPORATION

As each new man-made vehicle hurtles into outer space, industrial and military requirements become increasingly critical. Continuing research by Arcturus, however, has resulted in product improvement that has more than kept pace with technological advances. The Arcturus name, associated for many years with the capability of forging the most difficult configurations, has recently added to its reputation by accomplishing new design freedom through high energy forming of exotic metals. If you are faced with critical space age problems or need fast delivery and better service on stock items, turn to Arcturus. Write for our brochure. "Forging Ahead with Arcturus." Arcturus Mfg. Corp., 4301 Lincoln Blvd., Venice, Calif. ▪ UPton 0-2751

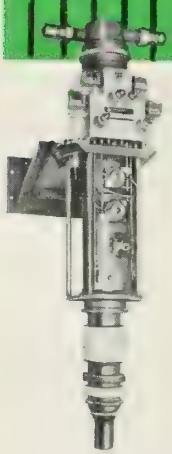



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The first link in Ace High, a four-station system called Hot Line, was installed in Norway in 1958. Varian's VA-800C amplifier klystrons are the heart of the system. Tube life to date is averaging over 5,000 hours. What's more, the average improves every day; two-thirds of the tubes are still operational. In fact, two tubes are over 13,000 hours.

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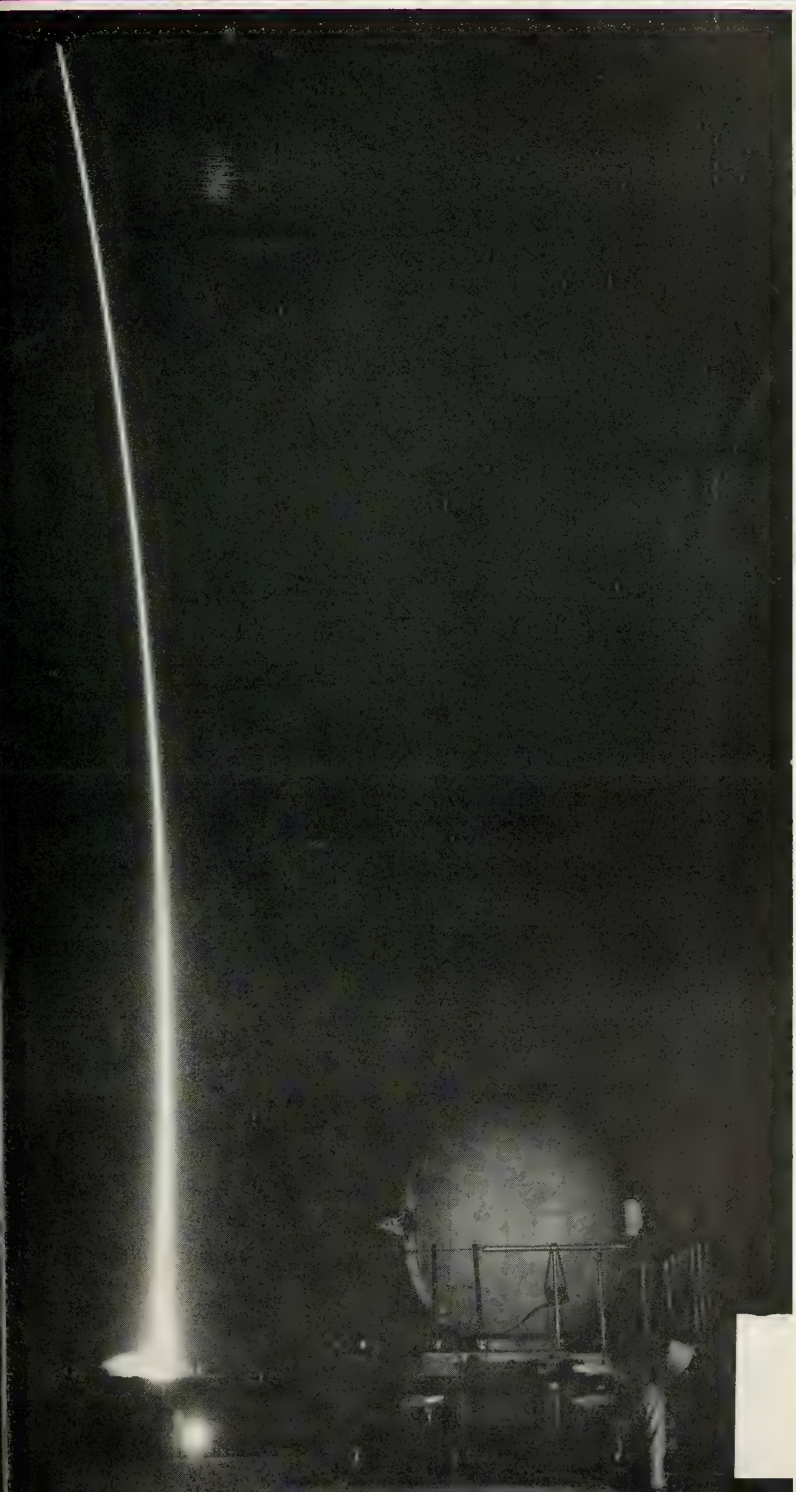
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FEBRUARY 27, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

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**4th Annual Electronics Issue**

## *Why the $1 Billion Guidance and Control Market Will Grow Bigger*

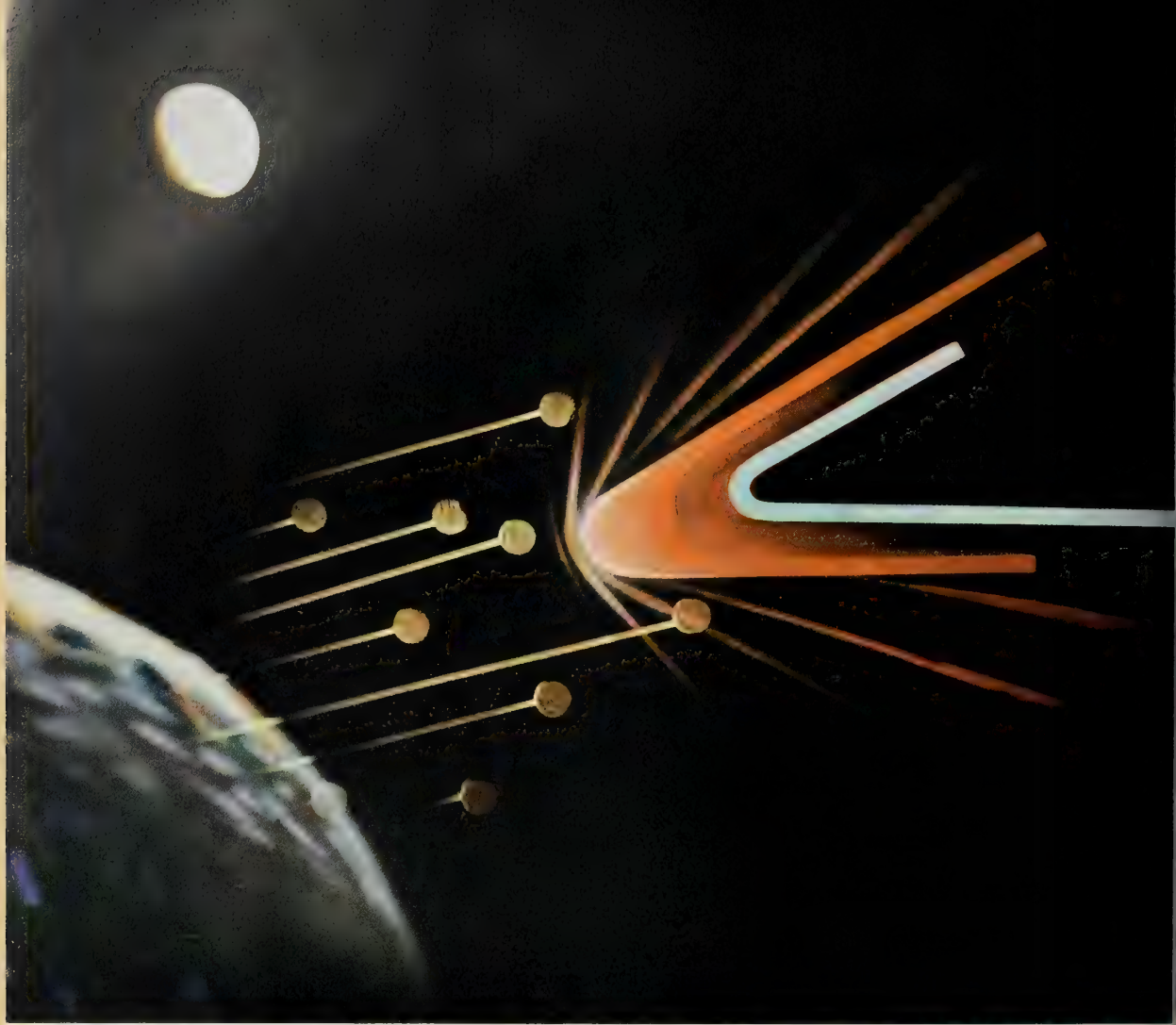
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Atmospheric friction which will slow tomorrow's returning space vehicles to safe landing speeds can make cinders of both space ship and occupants.

Bell Aerosystems has worked since the days of the X-1 supersonic research plane to beat this heat. We call our system Double-Wall. We've tested it — and we know it works.

Double-Wall is made up of a heat-sustaining outer wall, a sublayer of thermal insulation and a cooled inner wall. The fundamental principle behind this arrangement is the separation of the heat-sustaining and load-carrying functions of the airframe.

The outer wall is made up of small heat-resistant panels designed to withstand severe heating. It carries no structural loads, but serves as an effective heat shield by radiating most of the re-entry heat back to the atmosphere.

The layer of protective insulation is used beneath these panels to resist the flow of heat to the inner wall. The small amount of heat that does penetrate this insulation is absorbed and dissipated by an effective cooling system. Therefore, though outer wall temperatures may soar above 2000° F, the inner wall temperature will not rise above 200° F.

Significantly, the load-carrying structure is kept cool and strong, independent of external heating, and conventional aluminum construction can be utilized. As an added bonus the Bell Double-Wall's unique arrangement of thermal barriers automatically provides a moderate environment for both crew and equipment.

Double-Wall is only one of the many contributions Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

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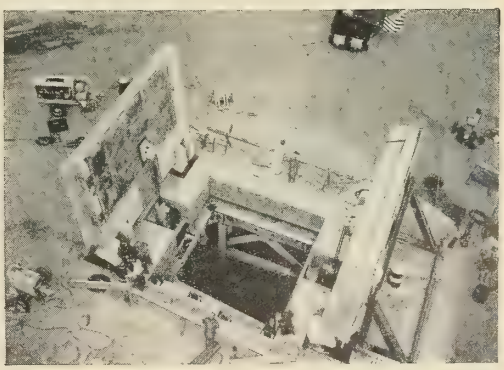
# General Electric Silicone Rubber helps get Titan ICBM combat-ready




**Missile and ground-support applications** are "naturals" for the unique qualities of silicone rubber—heat resistance above 600°F, low-temperature flexibility to −150°F, good thermal conductivity, unexcelled ozone resistance and virtually unlimited life under normal conditions. Because it retains its excellent electrical properties over a wide temperature range, G-E silicone rubber is also used for missile wire and cable insulation. Even when continuously exposed to direct flame, it forms a non-conducting ash which gives off no toxic fumes.



**Missile wiring harness** — General Electric silicone rubber was chosen by Aerojet-General Corp. for the Titan's propulsion system wiring harness. Breakouts and junctions are molded from G-E RTV (room temperature vulcanizing) silicone rubber; wiring is silicone insulated; jacketing is high-strength G-E silicone rubber. Inset shows silicone rubber inserts in connectors. RTV is used in other missiles as a shock-absorbing encapsulant and potting material for electronic assemblies.



**200 tons of steel and concrete** — Titan missile silo doors by American Machine & Foundry Co. use seals of G-E silicone rubber. AMF also used G-E silicone rubber door seals on the Titan's ground support entry portals and radar silos. Silicone rubber can withstand the heat of rocket blast-off or possible atomic attack while remaining stable in storage for long periods.

**GENERAL ELECTRIC**

**Write for more information on G-E silicone rubber, briefly describing your application. Section 0234, Silicone Products Department, Waterford, New York.**

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# Sperry "flies" them all

The highest levels of performance and reliability in pilotless flight are currently being attained at Sperry Phoenix. Working with the Department of Defense and in cooperation with other leading American defense contractors, Sperry has played a major role in "droning" virtually every type of airborne vehicle.

Soon the Lockheed F-104 – with a special Sperry drone stabilization and control system – will fly precision, unmanned missions for the U.S. Air Force at double-sonic speed and altitudes of 60,000 feet and above. It is the fastest of pilotless aircraft, just as the Sperry-equipped QB-47 is the largest. To meet the Army's difficult battlefield surveillance mission, Aerojet-General's SD-2 reconnaissance drone also employs Sperry stabilization and control.

No organization has had more experience in drone control than Sperry. Beginning with the first aerial torpedo in 1915, this experience covers a wide spectrum, including QB-17, QF-80, SD-2, QB-47 and QF-104. Sperry Phoenix now is delivering to USAF a revolutionary Microwave Command Guidance System permitting precision remote control o many types of pilotless craft over hun dreds of miles.

Sperry's pilotless flight capabilit encompasses both components and com plete systems . . . points to a host of nev applications, including the newest an most challenging—spacecraft and rocket booster recovery.

SPERRY

**SPERRY PHOENIX COMPANY,** DIVISION OF SPERRY RAND CORPORATION, PHOENIX, ARIZON



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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 9 February 27, 1961

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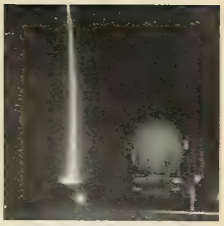
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## THE COVER

*Antenna in foreground beams command signals to radio-guided Titan I following launching at Cape Canaveral. (Photo courtesy Bell Telephone Laboratories. See story on p. 28.)*



## FEBRUARY 27 HEADLINES

## FOURTH ANNUAL ELECTRONICS ISSUE

GUIDANCE AND CONTROL—A SPECIAL SURVEY 15

Space Work Will Lift Market to $1.5 Billion .... 16
Gyroscopes of All Types Face Design Changes .. 21
Computers Will Determine Space Achievements 24
'MiniWeld' Provides Erector-Set Computers .... 26
Inertial vs. Radio Command: Which Is Best? .... 28
Weight Cut, Reliability Added in Atlas ..... 30
Titan II System to be Flight-tested Soon ..... 33
Minuteman Guidance Called 'Most Reliable' .. 37
NASA Ready to Decide on System for Saturn .. 40
X-15 Flight Data System Forerunner for Space .. 42
Dyna-Soar Will Rely on Proven Components .. 45

Fight Looms over Missile Satellite Defense Plans .. 77
Mercury Atlas Firing Buoys Man-in-Space Hopes .. 80
Transit III-B Firing Is Only Qualified Success ..... 81
Discoverer Program Scores Five Important Firsts .... 82
Explorer IX—First Satellite with All-solid Boost .... 83
Aerospace Projects Call for Tripling Technicians ... 85

## DEPARTMENTS

Letters ..... 8
The Countdown ..... 13
Industry ..... 70
Names in the News .. 74
Editorial ..... 92
When and Where .... 87
Reviews ..... 87
Products & Processes .. 88
Contracts ..... 90

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# memo from the publisher



HERRICK

WE ARE TODAY a nation of "space-conscious" people. Hardly a day goes by that a satellite launching, a new development in space medicine, a new design for manned spacecraft doesn't get top news billing.

Since M/R's very first issue, in October, 1956, we have placed high emphasis on editorial coverage of space systems and space engineering. From now on we'll increase our emphasis on space, taking a major step in that direction this week with the appointment of John W. Herrick as Space Editor.

Until now, John has been a member of the technical staff in the Office of Scientific and Engineering Relations at Space Technology Laboratories. He brings to his new job a wealth of knowledge in the space field.

He has had 23 years of experience as a design engineer concerned with rocket engines, missiles, space programs and test facilities. He's the author of "Rocket Encyclopedia Illustrated." His most recent activities at STL included the editing and publishing of two new monthly publications: *Live Deadlines* and the *STL Space Log*. He organized and directed the STL Space Information Center and Visual Aid Office.

A fellow of the Society of Technical Writers, Herrick as also a member of the American Astronautical Society, the American Rocket Society, the Pacific Rocket Society, the Air Force Association and the American Ordnance Association, and a fellow member of the British Interplanetary Society.

With MISSILES AND ROCKETS, John Herrick's main assignment will be to step up our coverage of activities in the space field. His addition to our Los Angeles bureau means that no other publication in our field—monthly or weekly—now maintains a larger fulltime West Coast staff. It also presents conclusive evidence of the high regard in which we hold the West Coast as one of the most vital areas of adequate missile/space industry coverage.

* * *

LAST WEEK on this page we mentioned that M/R's Special Report on *Nike-Zeus* had been inserted in the Congressional Record on Feb. 2 by Senator Strom Thurmond (D-S.C.). Less than two weeks later, on Feb. 13, M/R's exclusive report on the Soviet military budget (M/R, Jan. 23, p. 14) was placed in the Congressional Record by Rep. Overton Brooks (D-La.), chairman of the House Space Committee. These are far from being M/R's first two entries into the archives of Congressional proceedings, but, if memory serves us correctly, this is the first time it's happened twice in one month.

* * *

Speaking of the *Nike-Zeus* report, we now have available a limited number of attractive reprints of that special report. You can order one by sending twenty-five cents to Reprints, MISSILES AND ROCKETS, 1001 Vermont Ave., Washington, D.C.

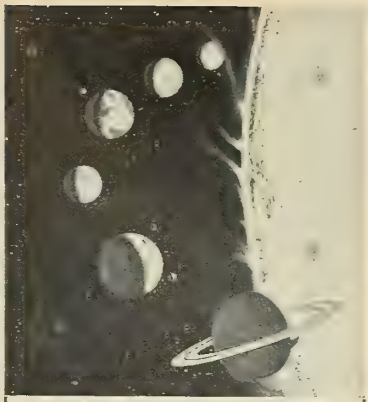
* * *

Those of you who frequently use MISSILES AND ROCKETS for research will be pleased to know that the Readers' Guide to Periodical Literature has selected M/R for indexing. Readers' Guide is received by approximately 11,000 libraries in the U.S. and abroad.

* * *

One of our important editorial tasks is to keep you up to date on the markets of the missile/space industry. You will find that the article leading off this annual electronics issue is the most thorough rundown on the billion-dollar guidance and control market compiled to date. If you are working in the field, thinking of getting in to it, or just plain interested because it's a vital part of our industry, you'll find it well worth reading. Electronics Editor Charles D. LaFond surveyed more than 100 firms in the field for the information. The article begins on p. 16.

Edward Michelfeld

## SPACE ENGINEERS

NAA's Space and Information Systems Division is taking an aggressive role in the nation's developing space program. Research is the key to the successful development and synthesis of the manned and unmanned space vehicles of the future. If you are a Physicist or Electronics engineer with an advanced degree—possess an innate curiosity about, and an intense interest in, any of the yet unexplored workings of the universe—let us tell you more about some of the key positions we have available in some of the following areas:

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# letters

## Fishing with Rockets

*To the Editor:*

We are interested in obtaining th names of manufacturers of small soli fuel rockets. These should be in th size range of those used to loft fi extinguishing bombs for the U.S. Fore Service.

We are contemplating the use of suc rockets to spread experimental fish net

Paul Kruse, Jr.
Fishery Methods & Equipment Specialist
Pascagoula Fishery Station
Bureau of Commercial Fisheri
Fish and Wildlife Service
United States Department of the Interior
P. O. Box 630
Pascagoula, Miss.

*Manufacturers please note.—Ed.*

## Photo Breakthrough?

*To the Editor:*

Your article on the *Samos II* (M/ Feb. 6, p. 15), quotes industry sourc as saying that the photographic equi ment in the 3½ x 4 ft. payload c take detailed photos at 300 mil equivalent to what the human e would see at 100 ft.

You question what the Russian r action will be to the *Samos*. If t Russians read MISSILES AND ROCKET I am sure the reaction will be comple and utter disbelief.

The human eye can resolve abo one minute of arc. If a camera were 300 miles, which is 16,440 times farth away than 100 feet, it would have t resolve 1/16,440 minutes or less th .004 seconds of arc. As any "indust source" can tell you, this is very hi resolution.

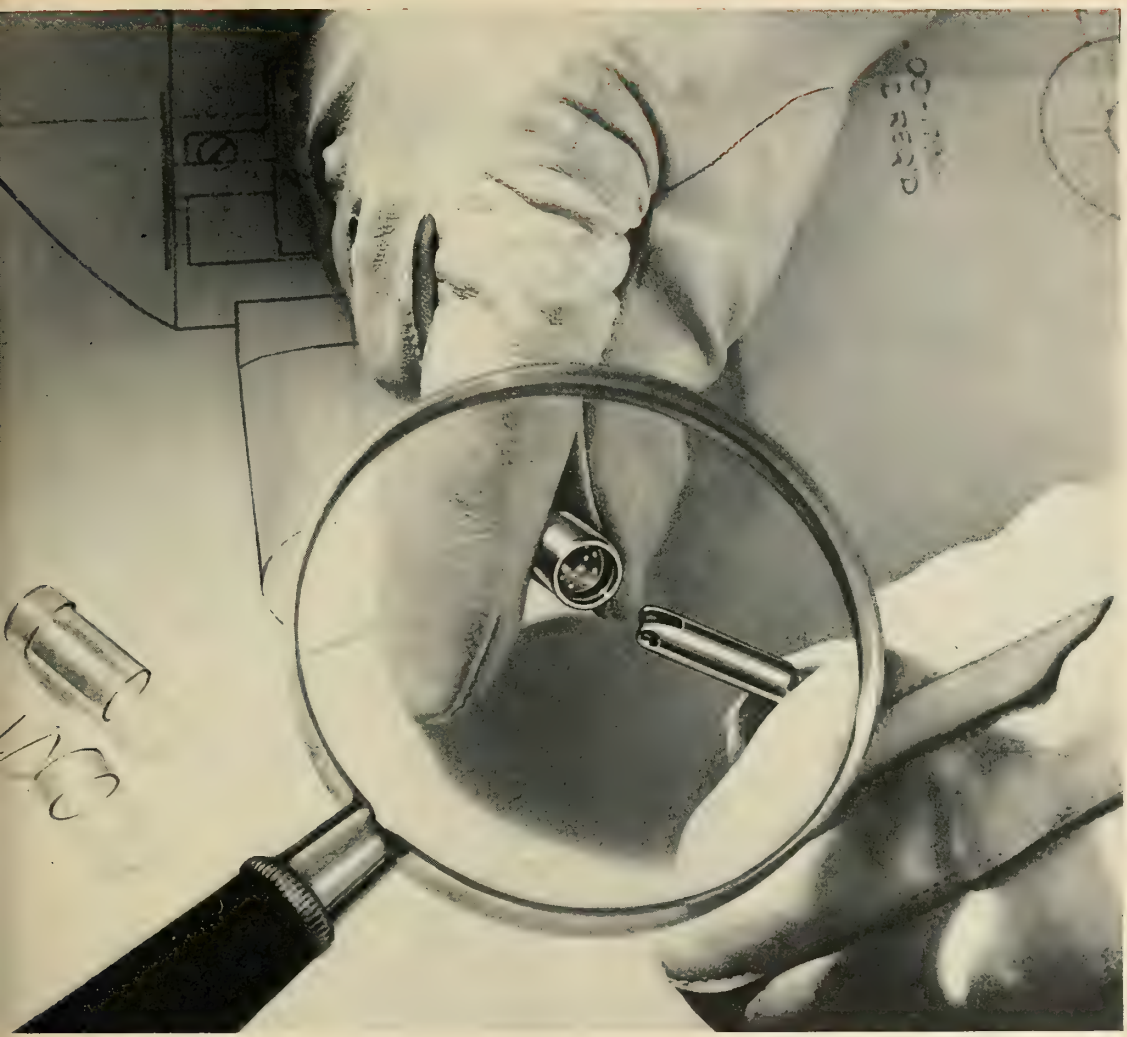
A rule of thumb for diffracti limited resolving power, using visi light, is that the diameter of the opt in inches equals 4.56 divided by t resolving power in seconds. 4.56/.0 equals 1000 inches in this case. T optics in *Samos II* must be the ultim in microminiaturization.

I hope I am not giving away formation which might shake the fa of the readers of MISSILES AND ROCKE

Morton H. Mehr
General Manager
Measurement Systems, I
Norwalk, Conn.

*No, but you are shaking the faith the editors in some of their sources. Ed.*

# IEW DEPARTURES IN MINIATURE



## OW TO GIVE ON-THE-NOSE GUIDANCE TO MODERN "FISH"

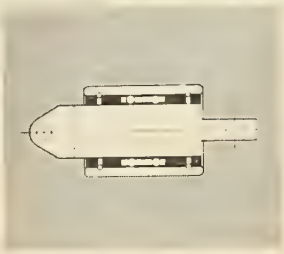
### NIQUE N/D LINEAR MOTION BEARING FREES GYRO CAGING ACTION

bearing illustrated is an N/D linear motion precision instrument ball bearing. It was cially designed and built to help solve a critical problem in the guidance system of a speed anti-submarine torpedo.

**OBLEM:** Loss of accuracy in torpedo's guidance system due to hang-up of caging arm yro assembly.

**LUTION:** N/D Sales Engineer, in cooperation with manufacturer, found that *wear* of ning on caging arm caused hang-up, delaying guidance activation. N/D Engineers to work to design and build an instrument bearing that operates virtually friction-The result: Preservation of the guidance system's pin-point accuracy and reliability.

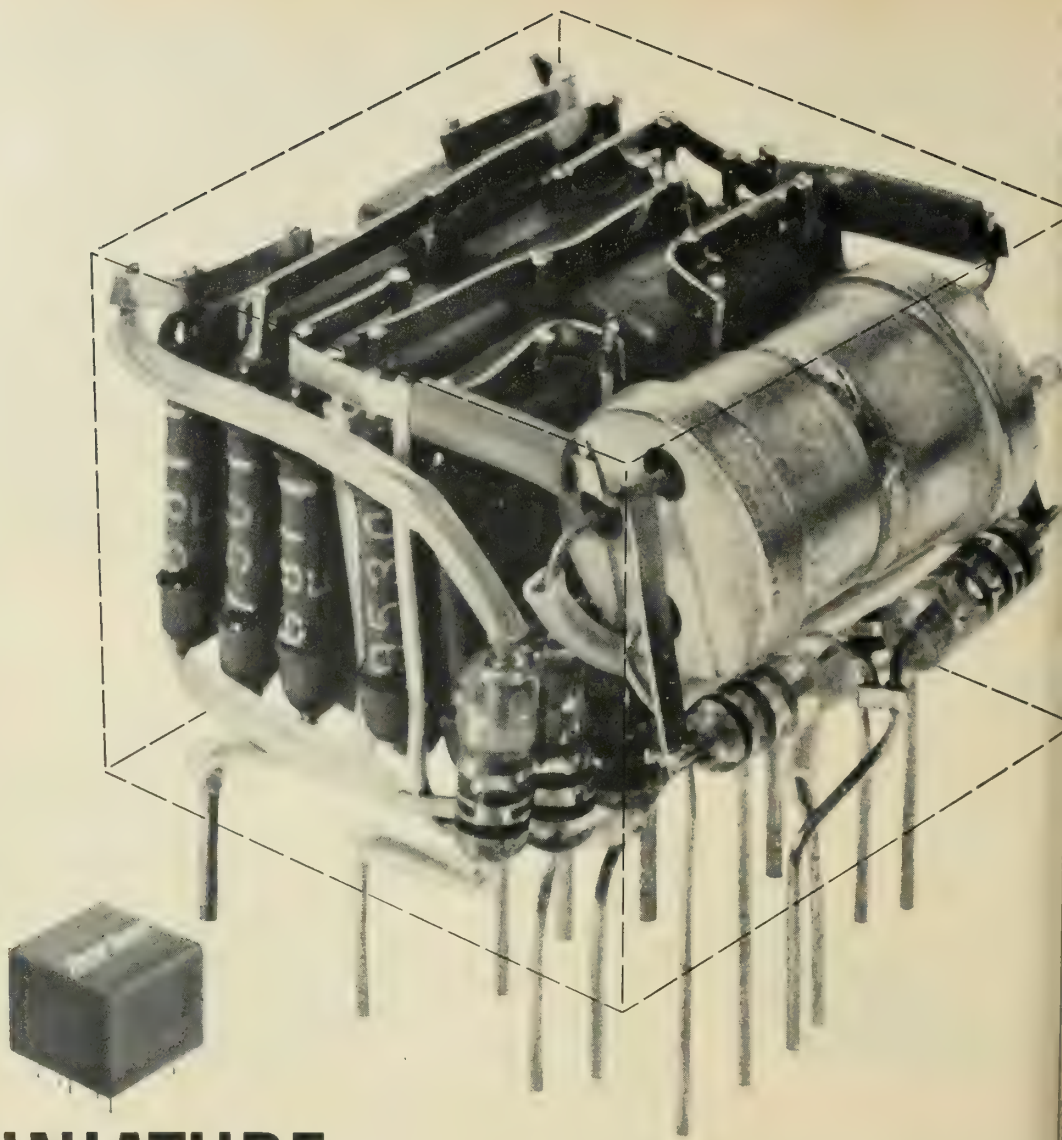
uld you require ball bearing design information, invite the local N/D Sales Engineer to cipate in your early design discussions. He represents one of the industry's largest neering staffs devoted exclusively to the design and development of ature and instrument ball bearings. Or, write for new Miniature and ument Ball Bearing Catalog, Department L.S., New Departure, Division eneral Motors Corporation, Bristol, Connecticut.



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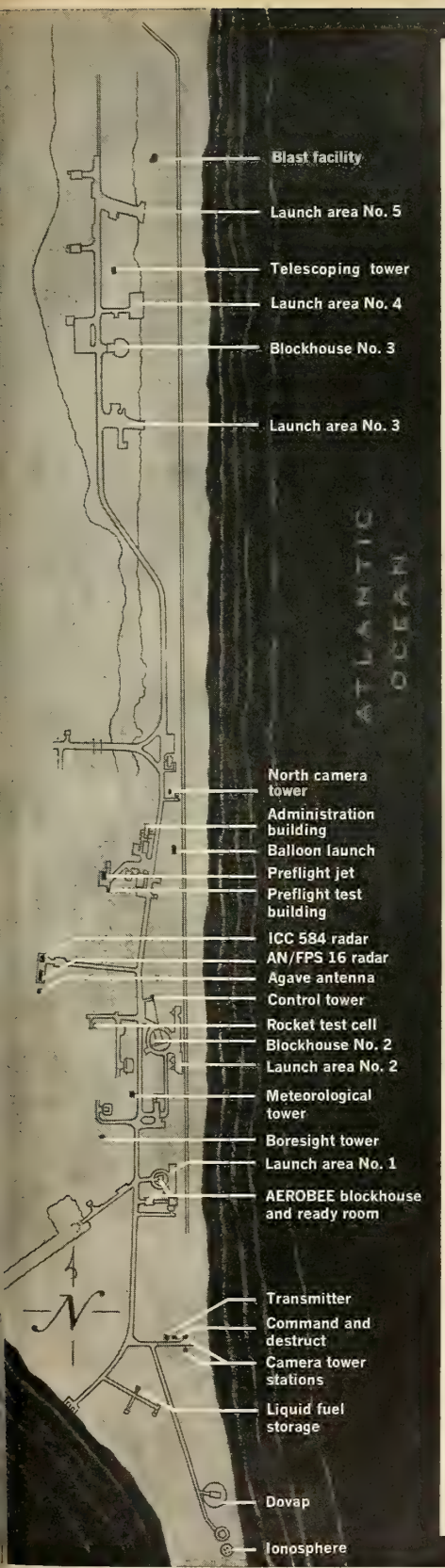
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# The Countdown

## WASHINGTON

### as AF Lost Counterforce Fight?

The Air Force appears to have failed to sell the Kennedy Administration on building a Missile Age Counterforce—a strategic striking force capable of prevailing in a nuclear war even after absorbing a surprise attack. Instead, the new Administration is now expected to buy a strategy of beefed-up minimum deterrence along with more limited war forces—particularly for the Army. Meaning in terms of hardware: Some more big strategic missiles, but the big slice of the expected $2 billion increase in defense spending will go to the tactical systems.

### Vill Dyna-Soar be Speeded Up?

ARDC is understood to be looking over proposals to more than double spending on *Dyna-Soar* and to get the space bomber operational sooner by going direct to manned orbital flights. Project officers say 19 months could be saved by skipping the first step—manned suborbital flights. This would make an orbital flight possible as early as 1963. Funding for FY '62 is $70 million under Eisenhower's budget. Acceleration would require jumping this to $150-200 million.

### IASA Cancels Atlas—Temporarily

COUNTDOWN hears NASA had a cancellation order on all plans for using *Atlas* boosters beyond the *Mercury-Atlas 3*. The order apparently was rescinded after the Feb. 21 success with *MA-2* (see p. 80). It is understood the cancellation was put into effect following the Wiesner Committee suggestion in January that NASA consider switching to *Titan* because of repeated failures with *Atlas*-based vehicles.

### Iercury—What Next?

NASA officials are having a tough time deciding the next step in the *Mercury* program. Up for debate: Is another *Redstone* flight needed to determine whether the booster malfunction in the chimp-carrying *MR-2* has been corrected; whether another capsule flight is needed to settle the leakage problem, and, if there is another, should it carry a chimp or go empty?

### iros Shot Moved Up

NASA is advancing the next *Tiros* shot to the second quarter of this year. This third weather satellite had been scheduled for the third quarter. *Tiros-4* has been added to the program and will go early next year. *Tiros-3* was moved up by bumping an *S-3* radiation satellite from a sixth *Delta* vehicle.

## INDUSTRY

### Vet Blanket for Big Solids

Top Air Force R&D officials are taking a dim view of industry claims of being capable of developing quickly multimillion-pound-thrust solid boosters. The officials say current studies of the future for huge solids are encouraging but still tentative. Moreover, they think it would be a mistake to fail to exploit the possibilities in developing medium-size solids first.

### Sensing Solid Rocket Failures

NASA is sending out a call for information to help man-rate big solid rockets. Solids Rocket Chief William Cohen wants to know where solids "telegraph" impending failure so that sensors can be placed to actuate an escape system. Cohen may award a study contract shortly.

### Aluminaut Decision Near

Office of Naval Research will decide within three weeks whether to go ahead with *Aluminaut*—the all-aluminum submarine for deep ocean research. The Reynolds Metals Co. proposal has been under study and design by Southwest Research Institute for two years. If Navy agrees to a long-term leasing arrangement, the sub will be built by General Dynamics' Electric Boat Division under a 1962 completion date.

### Redeye and Mauler Starve for Funds

Two hot Army projects—Convair's *Redeye* and *Mauler*—are suffering from serious fiscal anemia. The Army says both are undergoing painful stretchouts. For example, *Redeye* is now expected to slip about one year.

### Along Mahogany Row

Washington, D.C., industrialist William C. Foster is the new board chairman of Aerospace Corp., succeeding Roswell Gilpatric, who became deputy defense secretary. . . . Prospective merger between American Electronics and Electronic Specialties is understood to be off. . . . Thiokol expects sales to go over $200 million in 1961 and profits to improve substantially. . . . Stockbrokers are recommending Lockheed, Martin, North American, Northrop, Aerojet-General and Republic Aviation for their "near-term speculative appeal."

## INTERNATIONAL

### That Date With Venus

Estimated arrival of the Soviet space probe at Venus is now back at the original time—the last two weeks in May. Reports (M/R, Feb. 20) that the probe would arrive in mid-April are being attributed by the Russians to some garbled interpretations by a Soviet science writer, Harry Shternfeld.

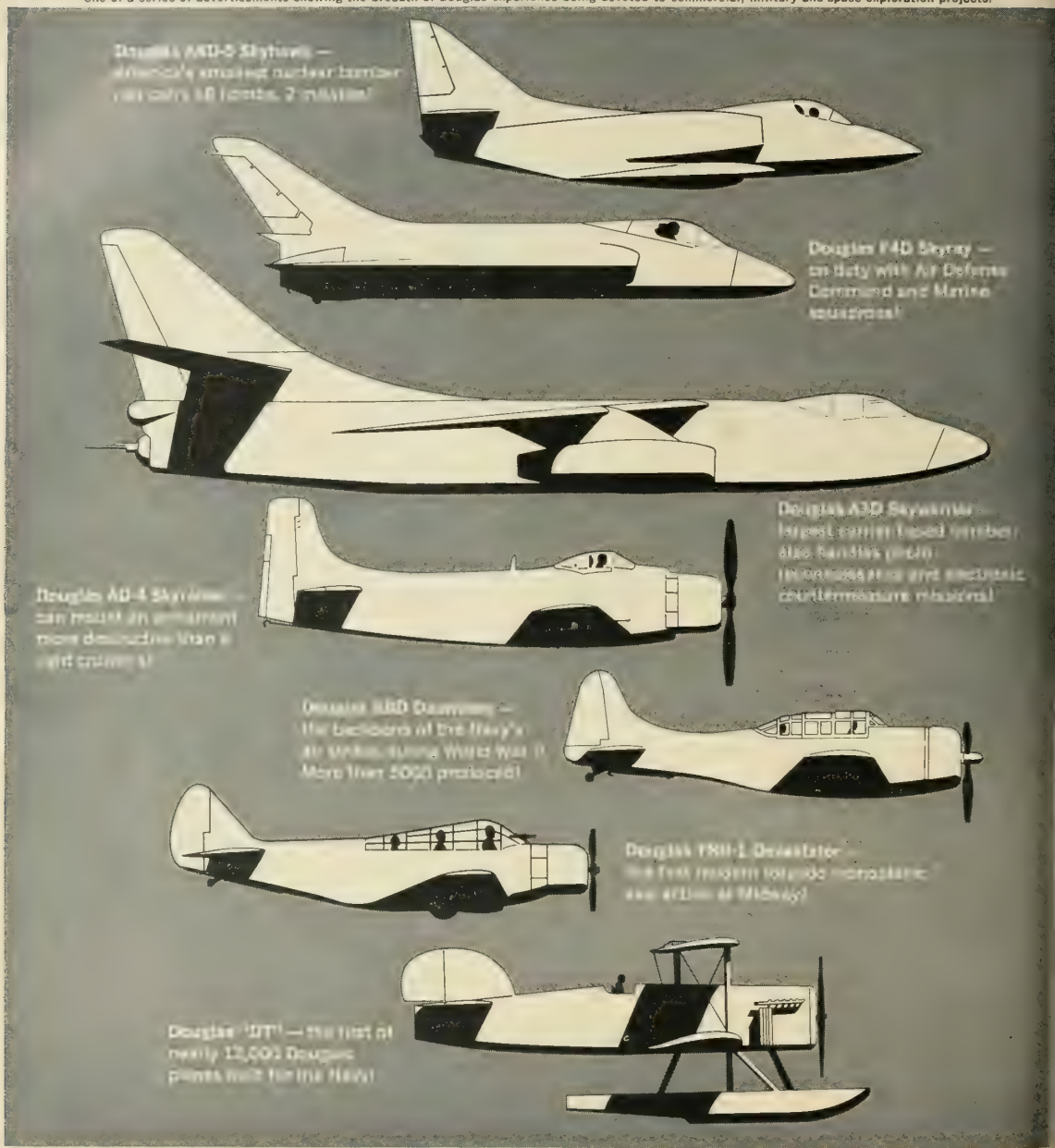
### Shuffle in Tracking Sites

There may be some new *Mercury* tracking sites, and some older U.S. tracking stations around the world may be dropped. Word is out that NASA/STL crews are being returned from Jodrell Bank and also from the Singapore site. Woomera is expected to become a key station in future operations.

### Overseas Pipeline

Five more high-altitude probes (around 1100 mi.) are planned by Italian scientists from the Perdasdefogu range on Sardinia using U.S. sounding rockets. . . . A French white rat named Hector survived a 95-mi. ride into the atmosphere Feb. 22 aboard a *Veronique* launched from Colomb-Bechar. . . . New Soviet MIG-21 Mach-2-plus fighter is said to be armed with four advanced *M-100 A* IR guided air-to-air missiles.

One of a series of advertisements showing the breadth of Douglas experience being devoted to commercial, military and space-exploration projects.



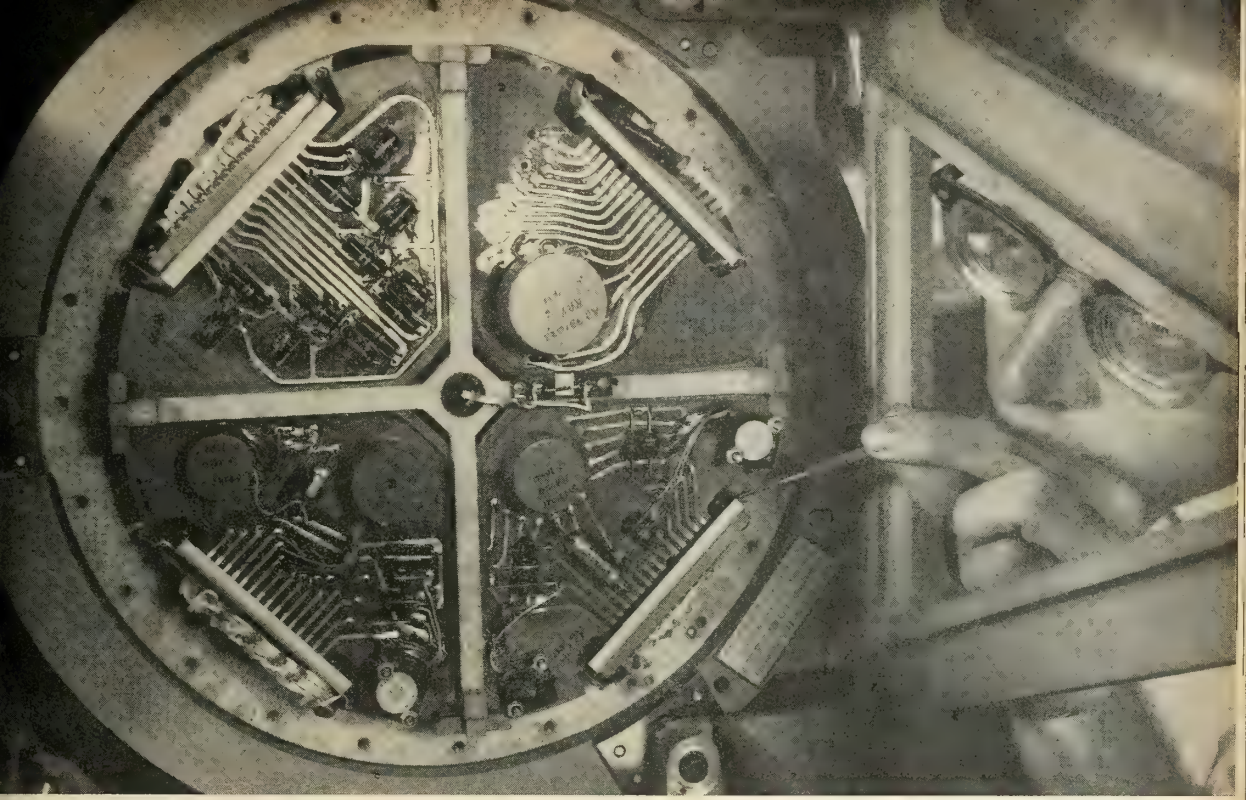

# Douglas refined 40 years of experience into versatile Navy Skyhawk

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*Honeywell's Scout guidance*

# M/R's 4th Annual Electronics Issue

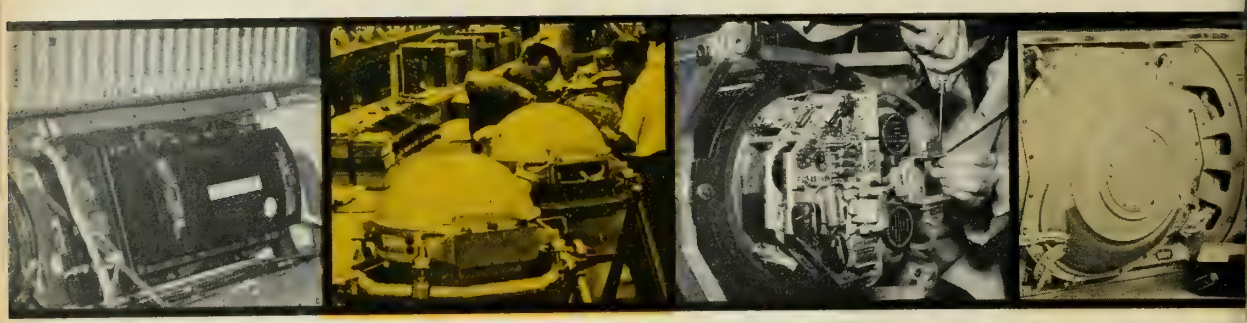
***Today, expenditures for guidance and control systems are commanding 20 per cent of all production dollars for missiles and spacecraft. The G&C market—already at $1 billion—is expanding rapidly. What are the powerful trends affecting this large segment of industry? Missiles and Rockets on the following pages presents the first careful analysis of the guidance field—including the first published breakdown of where the money is being spent now in missiles and space systems. And there's more in this special issue. The first complete roundup of gyro research and development; an 11-step program for improving guidance computers—plus:***

- ***Exclusive technical descriptions of an advanced inertial system for Atlas and the guidance packages going into Minuteman and Titan II.***

- ***First complete report of integrated G&C for manned space vehicles.***

# Space Systems Will Lift G&C

by Charles D. LaFond



***Inertial packages for missiles are expected to command 60% of $506 million to be spent by '65; biggest changes revolving about thrust/aerodynamic flight controls***

THE MISSILE/SPACE guidance and control market—excluding GSE—is nearing the $1 billion mark for 1961 and is expected to pass $1.5 billion by 1965.

As in any healthy market, changes are occurring which will alter the face of the industry: inertial guidance systems are on the increase, radio command systems are being de-emphasized, thrust and combined aerodynamic/-thrust control systems will slowly increase, while aerodynamic controls steadily diminish.

Technologically, the industrial parents of this young giant feel that it could use some rapid readjustment. It has grown from inadequacy to over-complexity in less than 15 idea-ridden, ambition-bitten years. Manufacturers have digitized, stellarized, miniaturized, transistorized and ruggedized; yet there still is a pressing need for greater reliability, sensitivity, producibility, and storability. Higher accuracy and lower costs would be welcome, too.

Nevertheless, such a vibrant industry can support the research effort necessary to solve these problems and even create new ones. Solutions are running about even with creations.

• **Strong market increase**—In its survey of over 100 G&C systems and components manufacturers, M/R received estimates as high as $2 billion for 1961. However, a conservative spread of from $730-900 million appears more realistic. This works out to be about 20% of the missile production dollar. A 50-60% increase in the whole market (see table I) is foreseen by 1965.

This amounts to about a 15% maximum increase each year which exceeds the anticipated 10%/year rise for the electronics market in general.

Dr. W. F. Ballhaus of Nortronics predicts that during the next 5-10 years guidance system R&D will account for up to 60% of total systems R&D. He bases his forecast on current demands for improved reliability and accuracy. However, he feels that as guidance systems go from R&D into production, guidance costs will drop to 30-35% of total expenditures. Others in industry agree.

The greatest problem in determining size of the market is in defining the market. Figures shown above refer to G&C systems, spares, RDT&E plus directly associated support systems. It is the "associated" equipment that clouds all estimates.

A general feeling exists among the larger manufacturers that as the market generally increases, a weeding-out process will occur. This trend is also true for the entire military and space electronics field. The field is diluted, but those who have failed to keep up in advancing their capability through concentrated R&D will surely be eliminated. Some have died, but this attrition has been counter-balanced by new entrants into the field.

The obvious change in emphasis from radio command to all-inertial guidance will take a toll, but mostly at the first and second tier subcontractor level. The radio-command guidance leaders also are among the inertial leaders. All their bets have been coppered.

• **Guidance trends clear**—A finer breakdown of the missile guidance and control systems field quite clearly reveals the trends for the next few years and probably for the next ten.

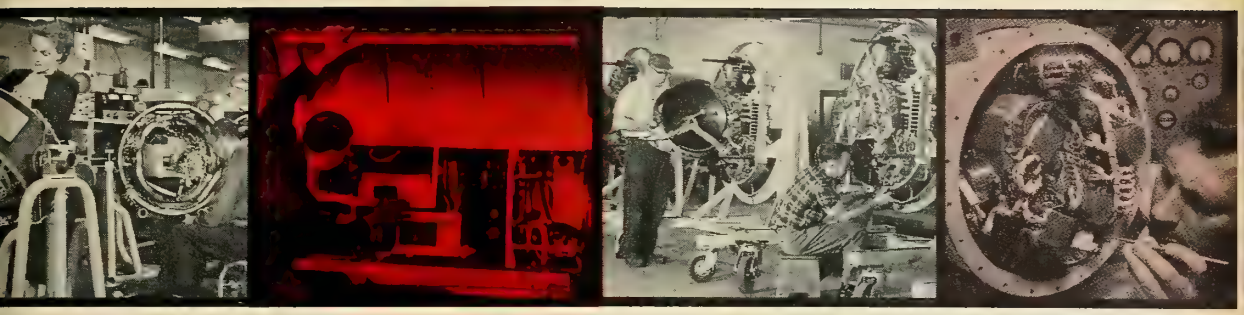
Mr. William Buckley, senior market analyst at General Electric's Light Military Electronics Dept. recently completed an extensive survey of this market. Excluding all associated equipment, and considering only the production costs for the G&C systems, spares R&D, and product improvement for known and reasonably assumed systems, Buckley predicts a total market of nearly $800 million by 1965 (see table II).

He further predicts a 25% increase by 1965 in the missile guidance market, with inertial guidance alone accounting for roughly 60% of the estimated $506 million total. During this same period command guidance, semi-active radar and infrared homing will decrease, Buckley asserts.

There will be some disagreement with the figures and even some of the trends reflected in table II. For example, several manufacturers closely approximate G.E.'s 1961 inertial guidance figure with its estimate of $265 million, but they also predict a '65 market of up to $475 million—or roughly $130 million more. Others predict even more growth.

Another area of sharp disagree-

# larket to $1.5 Billion



*LEFT TO RIGHT: Atlas-D radio command G&C, developed by General Electric; Atlas-E all-inertial platform (and system), developed by Arma; Titan I gyro reference, built by Honeywell for BTL radio command system; Polaris A1 inertial platform (and system), developed by MIT and General Electric; Thor all-inertial platform (and system), developed by AC Spark Plug; Delta radio command G&C, developed by Douglas Aircraft and BTL; Mace-A terminal map matching system, developed by Goodyear Aircraft; Scout inertial platform (and system), developed by Honeywell.*

nent is in the realm of optical and infrared guidance. Aerojet—General's Avionics Division did $8.2 million of business in this field in 1960, expects to reach $20 million in 1961, and $50 million by 1965. Others in the IR field concur. (More on infrared expectations later.)

The total missile control system market, according to Buckley, will decrease by $175 million through 1965. This heavy fall, he feels, will be caused primarily by a decease in procurement of missiles using costly aerodynamic control systems. (A sizeable production order for *Nike-Zeus* might alter this situation since it employs both aerodynamic and thrust control.)

Thrust control systems will certainly continue to increase steadily while the trend upward of reaction control at the present time is almost insignificant. These systems will enjoy increased use only when there exists a greater volume market for satellites and spacecraft.

• **All-inertial flourishes**—The market picture for missile/space inertial guidance systems as indicated above is one of assured and continuous heavy growth. Total estimate for 1961 is about $300 million; $475-500 million is expected by 1965.

Inertial guidance for space use offers the biggest question mark. For 1961, it is expected to fall between $4 and 6 million. Space inertial guidance use by 1965 is estimated wildly between $14 and 30 million. A more definite figure just isn't available.

Minneapolis-Honeywell, Arma, G.E., Autonetics, AC Spark and Bendix appear to hold a strong lead in this field. Their contracts on hand account for all of the funded large military/space systems. General Precision, Inc., Lear, and Sperry Gyroscope fall in line next with a variety of current programs. Hughes, RCA, Raytheon, Reeves Instrument, and Motorola have the capability and are ready to leap into the first open spot available.

Nortronics stands practically alone in the stellar-inertial field. It has pioneered in this field with *Snark* and now with *Skybolt*.

Daystrom, Summers Gyroscope, Bell Aerospace and Norden Div. of United Aircraft have been major suppliers.

It is also interesting to note that Minneapolis-Honeywell has a commanding lead in space vehicle guidance systems for 1961 (above 60%).

One point must be considered when discussing almost any type of guidance system and that is the tremendous in-house capability that exists among all of the large primes. Martin, Boeing, Douglas, Convair, Chrysler, McDonnell—any of these could break into the market as a subcontractor or associate prime, as Lockheed Electronics and Autonetics have done. Such a move could cause considerable reshuffling of rank in a relatively short time.

• **Radio command dwindles**—The Air Force has made no attempt to disguise its delight with inertial systems and the down-grading of emphasis on radio command guidance. Its *Thor, Hound Dog, Mace-B, Snark,* advanced *Atlas* and *Titan, Minuteman, Skybolt,* and *Dyna-Soar;* the Navy's *Polaris* and *Regulus II*; the Army's *Jupiter, Pershing, Redstone* and *Sergeant* are all medium to intercontinental range ballistic missiles and all use inertial forms of guidance.

Command systems found immediate use in the early *Atlas* and *Titan* models. These will be phased out. Other major systems employing command guidance are: (Air Force) *Bomarc A* and *B, Thor-Delta, Thor-Able-Star* boosters—although both use radar homing, *Bullpup*—via visual reference, *Matador*; (Navy) *Regulus I* and *II*; (Army) *Corporal, LaCrosse,* and *Nike-Ajax, -Hercules,* and *-Zeus. Bomarc-B* production has been curtailed; production has stopped for *Bomarc-A, Regulus I, Corporal, Nike-Ajax* and possibly *Nike-Hercules.*

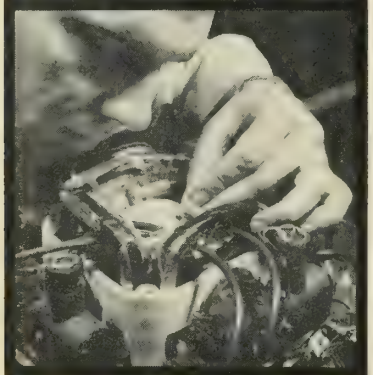
Only *Nike-Zeus* offers a sizeable market potential. (*Typhon* is still a question mark. It reportedly will use command guidance with a seeker).

• **A transluscent market**—That portion of command guidance systems carried in the bird is fairly discernible—a total of roughly $45 to 50 million in 1961. This is expected to drop to about $25 million for 1965.

But, by far the greater portion of











such systems is located on the ground. Radar transmitters, receivers, antennas, computer complexes, etc. These are big and costly.

The problem is where or how do you separate guidance from detection, discrimination, and target tracking processes. The market then merges with those of data processing and detection and tracking.

Not one guidance manufacturer contacted in this survey would hazard a guess. Neither shall we. Let it suffice to say that (1) it has been very big business (hundreds of millions), (2) it is a vanishing market today, and (3) a quantity production order for *Nike-Zeus* would return it to a top market position.

Leaders in this segment of the guidance field are Western Electric and Bell Telephone Laboratories, Sperry Gyroscope, Westinghouse, General Electric, Martin, Federal Div. of ITT, Lockheed Electronics Div. (formerly Stavid Engineering), and Kearfott Div. of GPI. Raytheon, Motorola, Sylvania, Philco, Stromberg Carlson, Texas Instruments and Litton Industries have been important suppliers.

• **Radar trends—up and down**—Active, semi-active, and passive radar homing represent another large slice of the guidance system pie.

Active radar (employing a missileborne radar transmitter and receiver) is relatively small today, but the trend looks like a sharply increasing market for the next few years with a growth from some $2 million in '61 to possibly $30 million by '65.

The reason is the same as for inertial systems—comparable accuracy, lower (eventual) total cost with negligible ground support requirements. Current systems include *Bomarc-A* and *B* (terminal guidance), *Eagle, Falcon-1 D* and *-3, Sparrow III, Sidewinder I-C,* and possibly *Typhon* (terminal guidance).

Leaders are Kearfott, Westinghouse, Philco, Bendix, Hughes, Raytheon, and Motorola.

Semiactive systems (target illuminated by a radar transmitter external to the missile, such as beam riders) appear to be following a downward trend: $80-85 million, 1961; $45-50 million, 1965.

Raytheon, Farnsworth, Sperry Gyroscope, Reeves Instrument, Federal Div.-ITT, and Westinghouse have led this field with systems in *Hawk, Talos, Tartar, Terrier,* and *Advanced Terrier.*

Passive radar guidance (homing on radar emissions generated by the target) is another market question mark. The Air Force *Arm* is a conceptual missile which has been studied for anti-radar air-to-surface use. Also, the Navy's *Cobra* is in early R&D for use against shipborne radar targets. No contracts have been awarded yet, but Martin, General Electric and Westinghouse are believed to have small company-sponsored R&D programs in this field.

• **IR market changes**—Opinions vary widely on the trends in the infrared market. It may be a case of the Haves vs. The Have Nots.

As indicated earlier, many predict pure IR homing as a decreasing market. The IR people say no. Most agree that hybrid IR/Radar homing systems are coming into their own during the next five years.

If the latter reach $20 million by 1965 or 1966 as has been predicted, this will represent a rapid growth and require volume production. This estimate only considers missileborne equipment and such systems are relatively inexpensive.

IR homing (passive use of thermal radiation from the target) is presently used in the *Falcon GAR-2* and *-4, Mauler, Redeye, Sidewinder,* and possibly *Shillelagh.* Hughes, Philco, ACF Electronics Div., Aeronutronic Div. and Motorola are systems suppliers.

The *Falcon GAR-9* and *-11* both employ hybrid IR/radar homing developed by Hughes.

Other important suppliers include Avionics Div.-Aerojet General, Chicago-Aerial, Eastman-Kodak, and Westinghouse.

Significant breakthroughs in IR system development could change the picture. One in particular is receiving considerable attention by Boeing, Bell Telephone Laboratories, Raytheon, G.E. and Westinghouse. They reportedly are concentrating on developing IR homing for AICBM's such as *Nike-Zeus.*

• **Map matching to gain**—Significant increase is predicted for terminal map-matching guidance systems from around $5 million in 1961 to about $35 million by 1965.

Used in *Mace-A,* the only operational system existing today was developed by Goodyear.

It may find use in future surveillance and target drones or new missiles now under study.

• **Other systems**—Radiometric homing systems may possibly be employed in the future. These home on thermal

*TOP TO BOTTOM: SOLO stabilized optical guidance system, developed by Chicago Aerial; G.E. electrostatic gyro operated for continuous periods over 100 hours; Honeywell electrostatic gyro may see use in Polaris-sub navigation; new missileborne analog-to-digital converter size cut by Packard-Bell; Vinco and Fecker sidereal rate stands test Atlas-E inertial platforms.*

adiation (from a target) in the microwave range. Other passive seekers the radio frequency and ultraviolet portions of the electromagnetic spectrum are being studied by Martin, CA, Westinghouse, G.E., and Motorola.

• **Gyro market large**—Total market stimates for missile gyros and accelerometers including R&D vary from 275 to $300 million for 1961.

(A very complete state-of-the-art undup of gyro technology by Mr. B. ichtenstein of Kearfott, appears on 21. The article provides an unusually detailed picture of current development and future research trends.)

In general the gyro leaders are so the top producers of accelerneters. Dollarwise and in total numer of units sold, two manufacturers and out: Minneapolis-Honeywell and earfott. Between the two companies ey have placed their guidance sens in almost every missile and space stem, past, present, and near future.

Those who are nearly as big in llars and number of units—but rgely because of captive markets—e Raytheon, Arma, General Electric, utonetics, Nortronics, Bendix, Ford strument and Sperry Gyroscope, AC ark, and Westinghouse.

Others who have done well in numer of units (all types) include Lear, hittaker Gyro, Reeves Instrument, mmers Gyro, Daystrom, Bell Aeroace, Giannini, Sanders Associates d Norden.

The gyro industry may see a arked change in this lineup in 5 to years. There are many exotic gyros w in development—some of these ay die, but others will replace existg types.

Such approaches as electromagnetic electrostatic suspended systems are ming for total freedom from friction. here are still many problems to overme, but these may well be tomorw's systems.

As we see it now, the penultimate proach could be the nuclear gyro. here is hardly a major producer day who is not investigating this ncept—the use of magnetically ined atomic nuclei to create a gyropic sensor.

Accuracies of the order of $10^{-6}$ gree/hour are believed possible with ch an approach.

How close are we to development such a system? Dr. R. L. Garman, ce president for R&D at General ecision Laboratories, flatly predicts at a nuclear gyro will be developed d in use experimentally within 5 ars.

• **Healthy computer market**—Curntly, the missile guidance computer arket is about $130 million. However, with the trend toward more and more inertial systems, these subsystems must also follow a parallel curve upward. By 1965, the market is expected to reach $185-200 million with R&D decreasing and production increasing.

It represents a good potential market segment for the vast computer industry. Yet, as has happened in so many other areas of the electronics industry, those who got in first probably will remain at the top.

Manufacturers such as Librascope, General Electric, Arma, IBM, Bendix pican Corp. for use in the *Polaris* guidance computers, will have a marked effect on the industry.

National Cash Register Co. also is making progress with its photochromic memory research. Responsive to light, these chemical cells offer promise of computer memories of unprecedented density for space use.

(A roundup of computer research trends is provided by Mr. R. R. Williamson of Librascope on p. 24).

• **Control systems**—Except for General Electric, Minneapolis-Honey-

## *Table I—Estimated Guidance, Control, and Associated Systems Expenditures for Missile/Space Vehicles**

(In Millions of Dollars)

| Market | 1961 | 1963 | 1965 |
|---|---|---|---|
| Total G&C—Missiles | 640-800 | 889- 895 | 996-1,120 |
| Total G&C—Space Vehicles | 090-100 | 235- 250 | 490- 600 |
| TOTAL | 730-900 | 1,124-1,145 | 1,486-1,720 |

**SPREAD REPRESENTS typical high and low figures of all industry estimates obtained from M/R survey of the field. Figures include expenditures for G&C systems, research and development plus directly associated external and support equipments, such as ground data processing, displays, and checkout, star trackers, etc. See Table II for complete breakdown of missile G&C systems only.*

and Autonetics hold, by far, the majority of contracts in this field. Their current R&D efforts indicate they intend to control the future market, too. Texas Instruments, Martin, Western Electric, and Motorola are doing well with guidance programers.

The trend so far has been for companies having guidance platform experience to also acquire computer contracts, although not generally for the same programs.

Sperry Gyroscope, AC Spark, Nortronics, Hughes, Packard Bell, Minneapolis-Honeywell, and Federal Div. of ITT with their present contracts have developed a capability and could snatch more of the market at any time.

Burroughs and RCA may be sleepers. So far they haven't really broken into the market, yet they have the hardware and R&D capability to move forward once they do break in.

And there are always going to be companies who make a component breakthrough that could catapult them into this field, such as Aeronutronic and Melpar with their work in artificial "nerve networks." Both have made significant bionics gains in developing electronic nerve cells for "thinking" machines.

The Miniweld fabrication technique (see story, p. 26), developed by Sippwell, Sperry Gyroscope, and Lear, missile/space control systems are in general held by the missile or guidance primes.

This is due largely because of the nature of the beast—a combination of electronics, hydraulics, and mechanics married to a frame, propulsion and guidance systems.

Total missile/space controls market for 1961 is estimated to be $300-360 million.

Table II shows a declining market for missile aerodynamic control and a steady increase in missile thrust control. There also will be a growing need for combined aerodynamic and thrust control systems.

Several adaptive electronic flight control systems are in advanced development by Sperry, G.E., and Honeywell. All are designed for use in aerospace-type manned vehicles.

Sperry has the integrated G & C system for *X-15*, while Honeywell's system is being developed for *Dyna-Soar*. G.E.'s system was developed under a WADD contract for aerospace use and will be tested in the *X-15* as will the first Honeywell system.

Lear controls are used in both *Pershing* and *Polaris*.

• **The part of testing**—The gyro test equipment role in producing guid-

ance systems is one whose importance and accuracy has grown with the rest of the industry.

In the 10 years following World War II, a 1000:1 improvement was made in the gyroscopic art. Now, many believe that additional 100:1 improvements will be made just over the next few years.

Specialized equipment and techniques are necessary to test such systems. Many were built by the missile and guidance primes simply because there was nothing available or because with modification some equipment could be changed over for the new requirements—centrifuges, special systems for rocket sled testing, electronic checkout gear, etc.

At the same time, specialists were brought in to build and develop operating techniques for super accurate gyro test and measurement. Thus, the gyro test table and electro-optical measurement devices came into prominence.

Two manufacturers, J. W. Fecker Div. of American Optical Co., and Vinco Corp., largely control the test table market.

As a measure of accuracy, gyro error is described by a drift rate. World War II gyros had drift rates in the order of 10°/hour. The gyros developed in the 10 years following the War and in use today, have a drift rate of the order of 0.1 to 0.01°/hour. Gyros under development today, but not yet in production, are expected to have drift rates of 0.001 to 0.0001°/hour.

The older 10°/hour gyros were tested by simply allowing them to sense rates or positions. Rates were produced by simple turntables having accuracies of the order of 1%. Displacements were produced by simple gimbal mechanisms and modified rotary tables. Accuracies of ½° were sufficient.

Equipment for test of present day gyros, according to Mr. J. Colker, chief engineer at Fecker, can produce rates with short term errors of 0.1% and long term errors of 0.005%. These devices, he said, are used to generate rates to be measured by the gyro and at the same time cancel out the earth's rate. In this measurement, gyro torquer current must be determined accurately (about 0.01%).

Test devices that rely on position measurement today have accuracies of ±1 second of arc. Such devices have glass discs with lines scribed every 0.1° and are read photo-electrically.

These, Colker feels, are adequate for present day testing. Today, in measuring a drift of 0.01°/hr. in earth's rate (15°/hour) we are looking at effects of approximately one in 1000 with a measuring instrument that is at least as good as one part in 10,000, or 0.01%.

For future testing Fecker would like an instrument accuracy of 0.0001% or one part in a million. Present rate generating and current measuring devices are far short of this goal. The Fecker position measuring device almost has this accuracy as long as the errors are distributed over 360°. Unfortunately, this is often not the case. Even more unfortunate, Colker said, is the difficulty in measuring errors smaller than 1 second, because so very often the error distribution is not known.

Existing accurate rate-generating devices use worm drives with long-term errors of ±3 seconds of arc, and short-term errors of ±1 second of arc.

Fecker is now developing equipment which requires the generation of rates to a short-term accuracy of 0.01%. To meet this tolerance an "electronic gear reduction" is used. Control of this system is completely digital.

Along with the development of high accuracy position and rate digital measuring systems, there is also a trend toward completely automatic testing.

Because of the large amounts of data produced in gyro test imposing a heavy burden of data recording and evaluation the majority of test equipment produced is semi-automatic. In these devices readout of data is automated and provided in a form compatible with general purpose digital computers.

The manufacture of gyro test devices requires that angles be measured to extreme accuracies usually to a second of arc or less. This measurement is accomplished optically using theodolites, autocollimators or interferometers. (See M/R Optics Report Aug. 22, 1960.) These measurements must be made under stable temperature conditions in areas of extremely low vibration.

• **Normal problems persist**—Reliability and accuracy lead everyone's list of problems associated with today's guidance and control systems. Of the manufacturers responding to M/R's survey of the field, 100% included these two items in their tabulations of improvement needs.

Equipment size, weight, cost, and sensitivity are the next most serious problems. Others feel system complexity is high on today's list of critical items.

Fred Stevens, Nortronics' pioneer guidance expert feels: "We are forcing performance with complexity. We've reached the point where a more mature approach to simplify systems is needed." Dozens of other leaders echo his belief.

Here are some of the other chief problem areas:

–Materials. Thermal and creep properties, especially in metals under tension, are a heavy contributor to gyro

*(Continued on page 57)*

## *Table II—Estimated Guidance and Control Expenditures by Missile System Type**

(In Millions of Dollars)

| Market | 1960 | 1961 | 1963 | 1965 |
|---|---|---|---|---|
| GUIDANCE SYSTEMS: | | | | |
| Radio Command | 52 | 44 | 28 | 25 |
| Inertial Guidance/Reference | 141 | 234 | 345 | 346 |
| Active Radar Homing | 2 | 2 | 20 | 31 |
| Semiactive Radar Homing | 94 | 81 | 64 | 48 |
| Passive Radar Homing | 1 | 2 | (?) | (?) |
| Radar/Infrared Homing | 3 | 5 | 10 | 18 |
| Infrared Homing | 20 | 22 | 10 | 2 |
| Radiometric Homing | ... | ... | (?) | (?) |
| Terminal Map Matching | 5 | 4 | 14 | 36 |
| (1)Subtotal | 318 | 394 | 491 | 506 |
| (2) Research & Development | 137 | 146 | 104 | 97 |
| **TOTAL** | **455** | **540** | **595** | **603** |
| CONTROL SYSTEMS: | | | | |
| Thrust | 17 | 22 | 23 | 26 |
| Aerodynamic | 178 | 188 | 143 | 117 |
| Reaction | 1 | 1 | 1 | 2 |
| (3) Subtotal | 196 | 211 | 167 | 145 |
| (4) Research & Development | 28 | 24 | 16 | 15 |
| **TOTAL** | **224** | **235** | **183** | **160** |
| Total G&C Systems (1, 3) | 514 | 605 | 658 | 651 |
| Total G&C R&D (2, 4) | 165 | 170 | 120 | 112 |
| **TOTAL** | **679** | **775** | **778** | **763** |

*DATA COMPILED in this table were provided largely through the efforts of Mr. William Buckley, Market Analyst in General Electric's Light Military Electronics Department, Utica, New York.*

# Gyros Of All Types Face Change In Design

by Bernard Lichtenstein

*Mr. Lichtenstein, a nationally known expert in the field of advanced inertial sensors and systems, heads the Applied Research Laboratory, Kearfott Division of General Precision, Inc.*

GYROSCOPIC DEVICES in the mediate and foreseeable future will ntinue to be the most convenient and actical flight reference instruments for titude and rate sensing.

As a consequence, their use in com- g years will continue to grow. How- er, their specific design and perform- ce characteristics will change.

Gyroscopes encompass a great va- ety of devices which vary in configu- tion, complexity, application, per- rmance, and price; but they all share e phenomena of precession and/or ertial rigidity inherent in a spinning, mballed, rotor.

• **Gyro fundamentals**—Of the many ethods of categorizing gyroscopes, one the most common is to refer first the degrees of freedom and then to e corresponding function. Accord- gly, they are usually referred to as ngle-degree-of-freedom or two-degree- -freedom gyroscopes.

Although within each category there e a great variety of design features d fabrication schemes, almost every ro can be fitted into one of these o categories.

Single-degree-of-freedom gyros in- ude two general types:

Rate: its output from the precession is is directly proportional to rate nsed by the gyro input axis;

Rate integrating: its output from e precession axis is directly propor- onal to the integral of rate sensed by e gyro input axis.

In a rate gyro, the preponderant straint about the precession axis is ring restraint; in the rate integrating ro, it is damping.

Two-degree-of-freedom gyros con- st of three general types:

Directional: oriented and gimballed that its output is an indication of imuth heading;

Vertical: oriented and gimballed so at it has outputs which are indications vehicle roll and pitch, measured from rtical.

Free: oriented and gimballed so at its outputs are a measure of devi- on from an arbitrary initial reference.

The differences between these three roscopes are essentially of a mechan- al nature—the directional gyro and rtical gyro have vertical references g., bubble switch) as part of their nfiguration, while a free gyro has me caging scheme associated with it.

• **Stable platforms** — In situations here it is desired to obtain information out three axes with an accuracy yond that available from simple gyros, gyroscopes are used in conjunction with servoed gimbal loops.

The gyros then need only sense their respective inputs which are used as error signals to control high-gain alignment loops. Whenever it becomes necessary to obtain drift accuracy better than 5 to 7 degrees/hour, the use of a stable platform is indicated.

The performance capabilities of a platform are a function of the gyro sensors. Platforms are usually built with three single-degree-of-freedom rate-integrating gyroscopes or two two-degree-of-freedom free gyros as the reference sensors.

• **From Falcon to Titan**—Gyroscopes are used as sensors of rate and indicators of attitude in missiles ranging in size from the 6-ft. *Falcon* air-to-air missile to the 90-ft. *Titan* ICBM; they guide torpedoes and also the subs firing them; they will guide the high flying B-70 mach-3 bomber as well as low flying, low-speed Army spotter aircraft.

It is apparent that one gyro or even one type cannot fulfill such a wide range of requirements. The range of performance capabilities reflected in anticipated duration of flight, acceptable weight and size, accuracy, and operating environments precludes any universal design.

There is also a continuing demand for improved accuracy. A more accurate gyro can mean a smaller CEP. This can result in a smaller warhead, leading in turn to greater range.

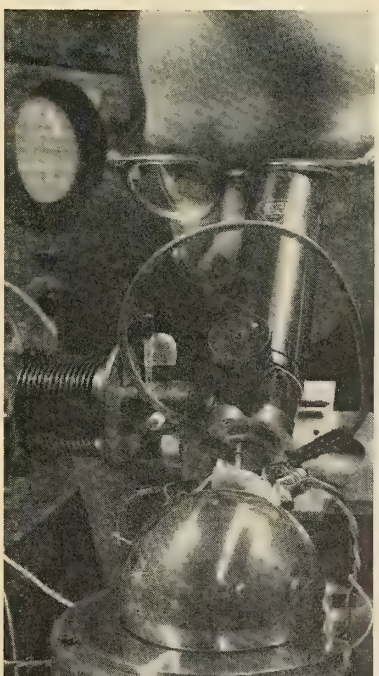
A corollary of greater performance potential, usually, is an increase in severity of environmental conditions.

• **Requirements fit mission**—The requirements of missile gyroscopes can be divided into two rather broad categories: (1) low accuracy, severe environment, and low cost; or (2) high accuracy, severe environment, and high cost.

Low accuracy includes gyros with drift rates ranging from 5 degrees/-hour to as high as 60 degrees/hour. High accuracy refers to those gyros intended for use in inertial guidance systems; these have drift rates of from 0.10 to 0.001 degree/hour.

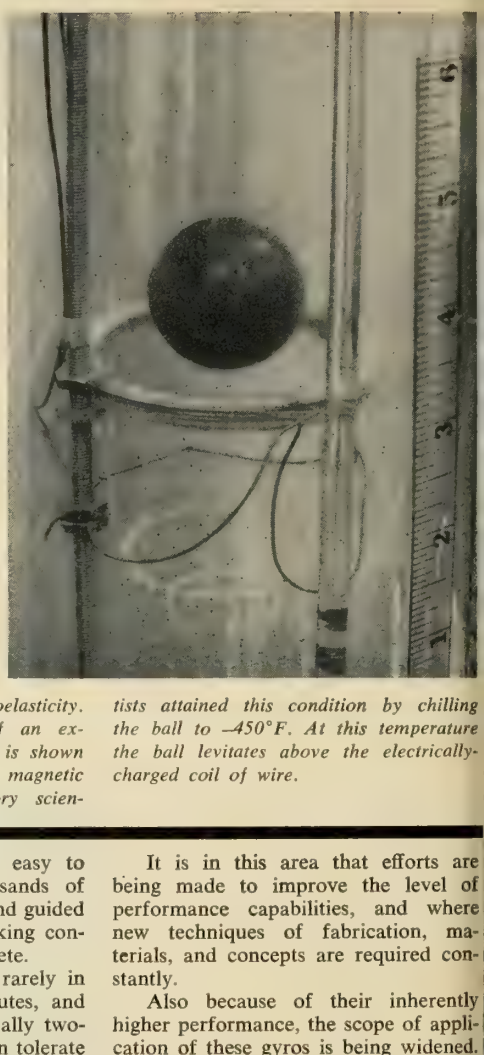
The range of drift rates between 0.10°/hr and 5°/hr usually is filled by stable platforms using non-floated type gyros and the range below 0.10°/hr by stable platforms with high accuracy gyros.

Low-cost gyros range in selling price from $200 to $2500 per unit. High-cost, high-accuracy gyros usually range from $6000 to more than $20,000 per



*BERYLLIUM sphere, machined by Honeywell to tolerances finer than 14 millionths of an inch, is rotor of electrostatic suspended gyro.*





**LEFT:** *Reductions in resonant gain from 14 to 4 are being achieved by Kearfott with laminated, damped structures. These structures are being incorporated into gyro gimbals to limit drift errors arising from gimbal anisoelasticity.* **RIGHT:** *Lead-coated rotor of an experimental cryogenic gyroscope is shown supported in a vacuum by a magnetic field. Jet Propulsion Laboratory scientists attained this condition by chilling the ball to –450°F. At this temperature the ball levitates above the electrically-charged coil of wire.*

unit. These high-priced units are usually fluid-floated gyros intended for use in high-accuracy inertial guidance systems.

The gap between $2500 to $6000 is usually filled by special versions of the two other categories.

Severe environments, for missile gyros, are conditions wherein the desired drift values referred to must be attained under vibration of 15g, shock loads in excess of 60g, a temperature range of more than 350°F, and bombardment by nuclear radiation, as well as exposure to fungus, dust, moisture, etc.

It would not be far from the truth to state that much of the engineering effort of gyroscope companies today is devoted to attaining current performance capabilities under environmental conditions of increasing severity, rather than improving on performance capabilities. (For example, the cageable free gyro [T2308], developed recently by Kearfott, has a drift rate of less than 0.5 degree/minute under 28g vibration.)

Low-performance, low-cost gyros represent the largest market potential for manufacturers in terms of units if not dollars. While a figure of hundreds of units for a given ballistic missile configuration is optimistic, it is easy to envisage production of thousands of units for the tactical missiles and guided rockets which are rapidly making conventional rifled artillery obsolete.

Such tactical missiles are rarely in flight for longer than 5 minutes, and their flight profiles are essentially two-dimensional. These missiles can tolerate drift rates on the order of 10 degrees/hour or more in many cases, and their trajectories do not require unlimited attitude capabilities about three axes.

The gyro requirement for such an application is not so much low drift as it is the ability to maintain the desired drift level under sustained acceleration during boost. Also needed are structural rigidity, small size and light weight, ability to operate either from a battery power supply or by a spring-wound motor or pneumatic power supply, and of course low cost. The anomaly of having a gyro cost more than the remainder of the missile is obviously intolerable.

The long-range ballistic missiles and the long-range, cruise-type vehicles, whether unmanned such as the *Hound Dog* or manned such as the B-70, will all require high-accuracy gyros. High performance is essential and high cost must be a secondary consideration.

It is in this area that efforts are being made to improve the level of performance capabilities, and where new techniques of fabrication, materials, and concepts are required constantly.

Also because of their inherently higher performance, the scope of application of these gyros is being widened. For example, where extremely high accuracy is required in the measurement of angular rates, the rate integrating gyro operating in a rate mode (i.e., where the gyro forms a closed loop on itself with its precession output being fed to the precession axis torquer) is replacing the conventional rate gyro.

The overwhelming majority of high-accuracy gyros are used in stable platforms rather than as independent sensors. However, there is growing interest in the use of what are known as gimballess platforms, or body-mounted systems in which the gyros are tied directly to the vehicle flight control system through a computer. (More on this later.) Such a scheme requires the high level of performance attainable only with the high-accuracy, high-cost gyro.

• **Design approaches and trends**—Now let's consider some of the design approaches firms are taking today.

It is important to realize that there n be more than one satisfactory solu-on to almost any engineering problem, d that the most important aspect of design is its successful implementa-on.

A well-thought-out conventional de-gn is preferred to one whose main aim to distinction is its novelty. This particularly true in missile applica-ons, where reliability is so important.

In the efforts being taken to im-ove the low-accuracy gyros as com-red to high-accuracy gyros, the chief stinction is that the former are largely ncerned with refinements and varia-ons upon known techniques whereas e latter are involved in new ap-oaches. However, in due time the lvancements in high-accuracy compo-nts trickle down in a modified and ss costly form to the lower-cost units.

In the two-degree-of-freedom gyros ed as vertical, directional, or free gyro ferences, with performance capabili-es of 5-10 degrees/hour, efforts are ing made to improve the structural sign of the basic configuration.

High g vibration inputs and accel-ations create anisoelastic torques and ass unbalances which cause gyro-drift rors. Larger bearings with higher con-ct angles, used in conjunction with iffer motor cases, have markedly re-uced mass shift errors. But it must be preciated that the gyro gimbals them-lves are capable of anisoelasticity.

Awareness of this is reflected in the anges being made in the shape and aterial of these gimbals. Laminated, mped structures which are now be-oming wide-spread in other areas have en already incorporated in gyro mbals.

A damped structure limits the reso-nt rise and transmissibility response a gimbal and reduces the natural equency of the structure, at the odest price of increasing the band-idth of the gimbal structure.

These laminated structures can be vers of similar metal, or alternating vers of dissimilar materials. Resonant in in gyro structure has been reduced om 14 to 4.

Vibration behavior in some gyros s been markedly improved by the e of classical tuned dampers, which ectively absorb energy from the main ucture.

There is an ever-growing trend vard using lightweight aluminum and gnesium alloys to meet the demand lower weight in airborne equip-nt. The need for low cost precludes use of beryllium or other exotic v-weight materials for low-accuracy os. However, beryllium does find despread use in the design and build-of high-accuracy gyros.

For extremely short-range missiles requiring gyros, a number of firms have turned to run-down gyros. These are units whose rotors can reach speeds of over 20,000 rpm by the use of a prewound spring or by the discharge of a gas cartridge.

Drift rates exceed 30 degrees/hour, but are satisfactory for the minute or so that gyro performance is required.

Summers Gyroscope and Whittaker Gyro make a large variety of spring-wound gyros; both Lear and Giannini have gas-driven run-down gyros in their product line.

By their nature, these devices are one-shot units, although in theory they may be reused. Their application is limited, but they do have the advantage of low cost.

Where accurate data for a longer interval of time is required, there are some gyros being built or designed for use with a battery supply. Two approaches are being taken. One is the use of a DC gyro motor. The other uses a conventional AC motor operated from a miniaturized solid-state inverter.

• **Future developments** — Looking ahead, preliminary investigations are now being made on gyros which will operate on pneumatic principles, using either a separate hot-gas generator or the combustion products of the solid-propellant booster.

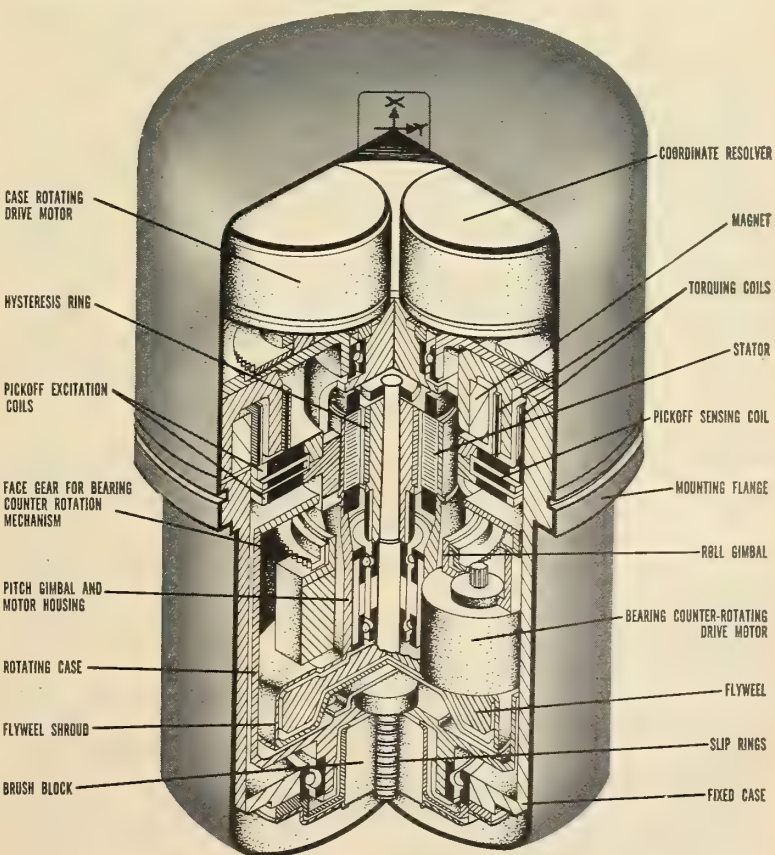
The former approach is being used by Kearfott in both a gyro and a computer element. Diamond Ordnance Fuze Laboratory is using the latter approach for a computer element it has developed.

The advantage of a pneumatic system is the elimination of costly electrical wiring, as well as the ability to operate at higher temperatures without cooling, plus, in some cases (e.g. missiles), a ready supply of energy.

In the field of the gyro rotor itself, the electric motor, particularly the synchronous hysteresis type, remains unchallenged where a constant speed drive is desired. Improved magnetic circuitry using ferrites for the motor is being pursued by Kearfott, as is the use of Hall-effect solid-state devices for output devices.

The Speidel Company is developing

*(Continued on page 52)*




Van Sag

*GYRO PERFORMANCE is being improved by adoption of new error compensation techniques. This is a Kearfott two-degree-of-freedom gyro that employs case rotation about an axis colinear with the rotor spin axis. The technique is designed to average out unbalanced forces about the axis.*



*INSTRUMENT PANEL for Project Mercury space capsule includes unique instrument called "earth path indicator." Developed by Minneapolis-Honeywell for McDonnell, device is a dead-reckoning computer containing a revolving globe which shows the Astronaut his position in relation to earth, and where he will land when he is ejected from orbit.*



# Computer Key to Space Achievement

## *U.S. manufacturers are proving equal to stringent demands for rugged small instruments; Librascope's Centaur unit is first*

**by R. R. Williamson***

THE SUCCESS and the scope of man's venture into space will depend on the development of missileborne digital computers to provide vital computation, control and memory functions beyond human capability.

This type of computer exceeds ground-based systems in its requirements for reliability, low power consumption, light weight, small volume, and resistance to severe environmental factors. The instrument must function in a wide temperature range and under severe vibration and g-loads. It must also meet specified computation rates.

Today, these design problems are being met. Digital computers for space application have been designed and produced by many competent U.S. manufacturers.

In its first outer-space application (the *Centaur* computer developed by Librascope Div. of General Precision, Inc.), the digital computer will provide guidance computations and initiate vehicle-control signals.

In the future the computer also will provide control of scientific equipment for experiments performed by unmanned spacecraft soft-landed on the moon, or perhaps on some distant planet. Storage and processing of data from the experiments will then also become a computer task. Missions of this nature may require two or more computers aboard the craft.

When man himself is finally included in the payload, the computer will serve as an auxilliary to the crewman's intellect and, in the automatic control function, it will multiply his muscle power.

At the same time, the engineering of a man into the spacecraft system will impose additional and vital duties upon the computer. Life-support systems will need the automatic monitoring and automatic control that the computer can provide.

• **Genealogy of a computer**—When man makes his first flight in a true spacecraft, he will be accompanied by a computer (or computers) that will trace a family line back to the first digital computers flown successfully in aircraft.

Among these was the CP-209, Librascope's first entry into the airborne digital computer field. Even though this project began in 1952, the division's engineers continue to study this computer under operational use in Navy bombers, knowing that the lessons of today will be the key to tomorrow's problems in outer space.

For instance, since this computer involves a digital differential analyzer, its resolution of navigational problems with respect to real time has a definite relationship to guidance in space.

Further, important lessons were gained in the division's laboratories through the development of the AN/ASN-24 for Wright Air Development Division. This instrument, delivered in 1958, became one of the country's first solid-state, digital computers for airborne use. Today, it is fully ruggedized and miniaturized, has a volume of only 0.55 cu. ft. and weighs 37 lbs., excluding input/output.

The need for "off-the-shelf" hardware with proven reliability led to the selection of Minneapolis-Honeywell and Librascope to provide the inertial platform and the computer for the total guidance package in Convair's *Centaur* space vehicle.

While this package has received wide publicity as the first digital computer to be employed in a space vehicle, other engineering groups within the division have been making approaches with no less notable achievements. One example has been the completion of a digital computer which had to be designed around the packaging criteria of a unique (and still highly classified) military missile configuration.

With an eye to tomorrow, the division is working on an expandable airborne computer and an approach to the computation requirements for strap-down inertial systems now in development.

A solid-state memory is under development for a guidance system applicable to an operational *Saturn*-type space vehicle. This unit is comprised of one-inch cubes of silicon wafers

*Mr. Williamson, now director of military sales for Librascope Division, General Precision, Inc., served previously as a staff engineer and later as director of advanced systems and planning in the company's aerospace branch. He has been a major contributor to digital computer design and development, and holds several patents in the field.*

th etched and vacuum-deposited mponents and circuitry. Storage pacity will be 70,000 bits per cubic ch.

In time, many believe, an all-solid-ate inertial guidance system without y moving parts will evolve.

This is but a thumbnail sketch of st one company's work in this area. brascope is not, of course, alone in competence in this field.

• **Centaur will lead the way**—How-er, it does feel that the first use of e digital computer in the *Centaur* ll carry with it the philosophy of sign, demanded by the space applica-n, that will be seen in the develop-ent of tomorrow's guidance com-ters.

It is a lightweight, miniaturized, neral-purpose instrument, employing lid-state components and printed rcuits. Of utmost importance during development was the need for care-l decisions on components, packag-g and logical design to insure re-bility.

The *Centaur* computer employs a um memory, a proven device neces-ry for the rigors of space environ-ent. Other devices will no doubt pplant the drum. But it still remains effective answer to today's demands r economic utility and reliability.

• **Eleven urgent needs**—Reliability the essence of space application. ach of the future needs in computer velopment is based on this require-ent.

The reliability factor cannot be nited to the computer alone, nor can e afford to focus our attention on y particular component of the com-ter.

The approach must be taken from e systems viewpoint. It means little have a computer function perfectly, a sensing or control device fails.

Reliability starts with the analysis our needs and problems, and in the ncept we apply as a solution.

The key here is conceptual sim-icity—simple in form but capable solving problems.

This point, reliability, is the first of even requirements for the future.

The second is a reduction in reac-n time. This would apply particu-ly to the military area. Needed is the mination of pre-checking, prealign-ent, and the time-consuming prepa-ion of a guidance device before unch. Here again we ask for sim-city. The approach here would be design.

A third requirement is the reduc-n of power needs. The benefits uld be in weight saving and, again, proved reliability by reduction in at generation. (For example, in the *ntaur* application, Librascope pro-vided the computer with the capability of turning itself off when not in use to meet the recognized need of lowering power requirements.)

A fourth point is the need for all-solid-state devices, not just computers, in space. This means, simply, no rotating parts that take energy to counteract. Again we find the benefit of higher reliability with the elimination of moving parts that can wear out.

Fifth, we should note that so far only digital computers have been mentioned. We face an added need for optimizing the use of analog and digital equipment in space systems to insure that we are making effective use of our resources in meeting the problem.

Redundancy is the sixth point. Effective use of this technique at many levels of our space systems will again enhance the reliability factor.

The seventh point has been touched on, but it bears repeating: The guidance approach toward the spacecraft problem is tending toward a combination of inertial-optical-angular position sensory equipment. This has been recognized, and many have long concentrated their efforts in the area of optical devices and sensing equipment.

The eighth requirement—a long-range consideration—is that molecular electronics will be phased into use for computers in space. But before this happens, we will see a reduction and improvement of interconnectors in present-day equipment. This will be a design approach and will provide an increase in reliability. Actually, the interconnector problem must be solved before the technique is perfected.

As point number nine, we should again stress the need for over-all system simplicity. This has to be approached on every front of the design problem. It might be beneficial, in the interest of reliability and simplicity, to consider the use of a number of simple computers in a spacecraft in lieu of a single multipurpose instrument.

Also (as the tenth requirement), we have the necessity of providing a means for easy maintenance of equipment. The man in space will depend on the support of computerized systems. If necessary, he must be given the means of quickly repairing any portion of the system and restoring its usefulness.

Lastly, I return to my opening statement. The digital computer will be the keystone of our space venture. Development progress will, of course, come about as a result of the broad growth of technical competence in this area. Nevertheless, as an essential building block for this program, it deserves a concerted and continuing effort by all concerned with this quest.





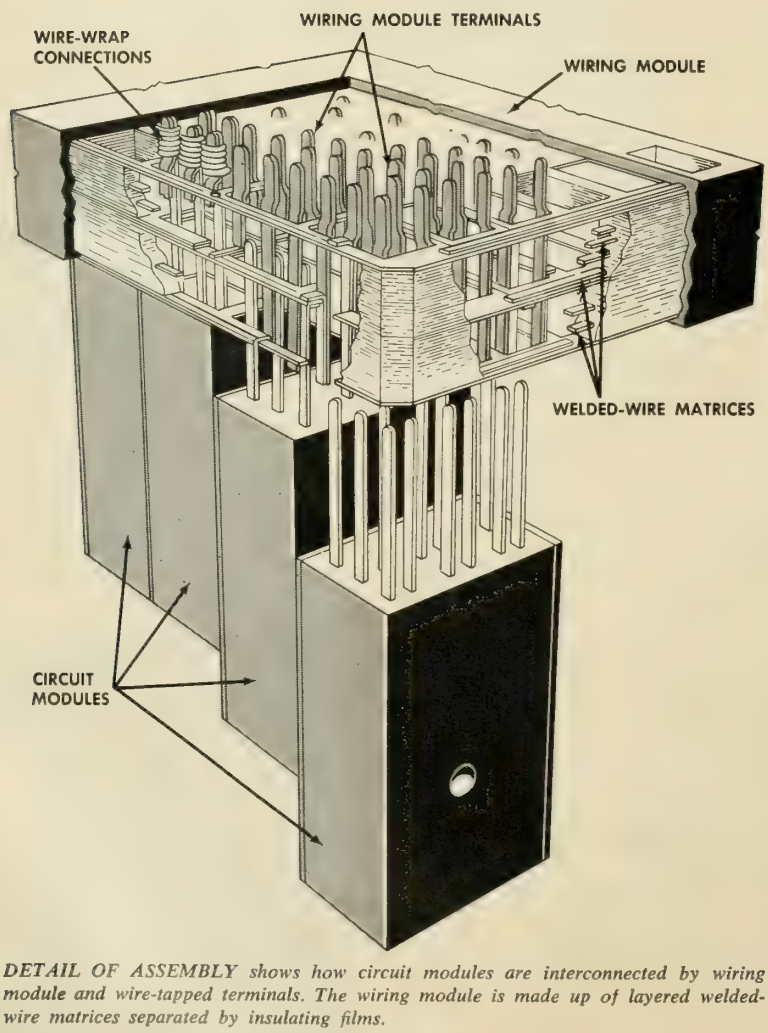


**TOP:** *Silicon permanent array memory, developed by Librascope, employs these discs as major components. Each is only 0.008-in. thick, 1 in. in diameter. Dots are diodes. Later production includes etching and diffusion to isolate diodes.* **MIDDLE:** *Centaur digital computer (left) and input-output equipment (right) produced by Librascope weighs 57 lbs. overall, is gold-plated to aid in temperature control. Magnetic memory provides total storage of 2560 words, each 25 bits long.* **BOTTOM:** *Miniature airborne drum assembly developed by IBM Federal Systems Div. laboratory weighs 8 lbs., compared with 235 lbs. for conventional drum assemblies. Slider bearings ride thin layer of air on drum's surface.*

# Erector-Set Guidance Computers

***'MiniWeld' technique invented by Francis Associates used to build systems for the Polaris, Minuteman, space vehicles; sales of nearly $1 million seen this year.***

**by Hal Gettings**




*DETAIL OF ASSEMBLY shows how circuit modules are interconnected by wiring module and wire-tapped terminals. The wiring module is made up of layered welded-wire matrices separated by insulating films.*

TOMORROW'S GUIDANCE com puters may well come from a Space Age supermarket where the parts ar bought off the shelf and put togethe like a combination egg-crate and erec tor-set.

The high-density standardized ci cuit packages and modular hardwar for such electronic systems are alread on the market. With the new technique called "MiniWeld," complete system may be made up with compatible dig tal circuit modules, intercircuit wirin modules and cabling, and mechanica and thermal building blocks. Up to 20 circuit modules—counters, storag units, delays, drivers, inverters, an logic blocks (NOR, NAND, pulse, an DC)—may be assembled into syn chronous or asynchronous system Over 150 different digital circuit mod ules are available from the manufac turer.

This new system concept uses sev eral unique techniques in the diffe ent components. Welded-wire circuitr is used exclusively in both circu modules and interconnecting wirin modules. The Bell-developed wire-wra method is used instead of convention connectors to give inherently high reliability.

The unique mechanical assembly o the completed system makes it esse tially a solid block with high resistanc to shock and vibration. Disassembly simple, however, and units can be r placed in a minimum of time. Coolin can be incorporated in the packag to meet any design demands.

The MiniWeld technique receive the 1959 Miniaturization Award—th first ever given for a total system co cept. The technique was invented b Francis Associates and developed b Sippican Corp. Electronic Engineerin Co. of California did systems R&I their affiliate, Engineered Electronic builds and sells the packaged circui and mechanical components.

Versions of the MiniWeld syste are being built for use in *Polari Minuteman,* and various space vehic programs. Almost $1 million wort of the equipment is expected to be so in 1961.

The Mini-Circuit module is th basic unit in a MiniWeld system. The modules are assembled parallel to eac

other in an erector-set frame—similar to the way eggs are crated—and held together in compression about a central plate. The minimum frame holds a stack of 10 modules, the maximum 200. When more than 200 of the modules are required in a system, the frames may be stacked together. Where needed, "cold-plate" building blocks, which provide cooling ducts, are assembled adjacent to the circuit modules.

Interconnections between the various modules are made by means of a wiring module which fits on top of the frame. Circuit terminals project through the wiring module and match up with interconnection terminals. These pairs are then connected by wire-wrapping. Cable modules—made of flexible printed wiring and potted terminations—carry signals and power between frames and to front-panel devices and accessory assemblies.

The complete frames, with their wiring modules and interconnecting cables, are stacked on a cooling-fan assembly and bolted to the holding structure. Clamping bolts, inserted through each row of modules and pads at each end, hold the modules together to form, in effect, a homogeneous whole.

• **Mini-Circuit Modules**—The welded-wire matrix (M/R, Oct. 10, 1960) is the basis of construction of the individual circuit modules.

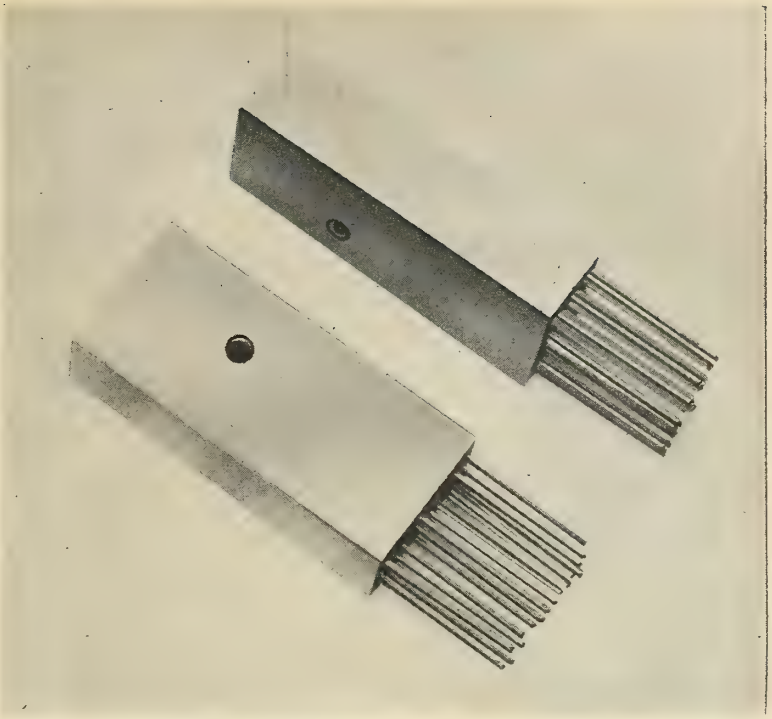
The module components are stacked with their bodies in physical contact and their leads parallel—in a "cordwood" technique. Components which vary in size or shape are arranged to fill the least possible space, taking into account their thermal and electrical characteristics. High-power dissipating components, for instance, are given special consideration in the component layout.

Mylar films, with the cross-sectional dimension of each component drawn in full scale, are used to arrange the components in proper order during fabrication. Dots on these positioning films indicate where holes must be punched to accept the component leads.

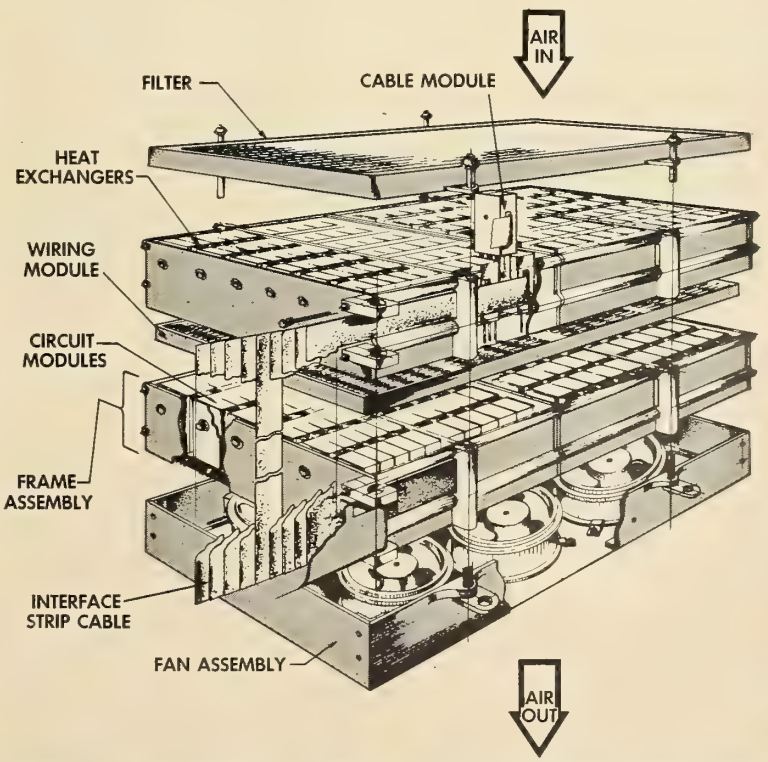
Connections between components and to Mini-Circuit terminals are made by the welded-wire matrix. Resistance-spot-welded connections are used because of their inherent reliability, volumetric efficiency, and elimination of thermal damage to sensitive components during assembly.

The matrices consist of two layers of wires at right angles to each other, separated by a Mylar film. Welds may be made through holes in the Mylar to make connections between the perpendicular matrix wires, or from a

*(Continued on page 58)*



*CIRCUIT MODULES are made of welded-wire matrices which hold and connect the various components. Connector terminals are welded to the matrix pins, and the entire assembly is encapsulated in an epoxy resin.*




*MODULAR COMPONENTS of the MiniWeld system are stacked and bolted together to form a compact and rugged package. The cooling unit, if needed, is an integral part of the total system. Minimum external wiring is required.*

# Which Is Best Approach

***The Case for Radio Command: Accuracy flexibility, low weight and small size combined in system which can be produced now; hardening is possible, jamming impossible***

by L. J. France and
R. C. Litty*

## COMMAND

THE TECHNIQUE of guiding a missile by a radio command link from the ground results in the most accurate, most flexible, and the smallest and lightest guidance system available today. Advanced radio-guidance techniques provide phenomenal accuracies —and they are ready for immediate hardware implementation.

Certain primary advantages attributed to inertial guidance have been instrumental in establishing its present status. These include four impelling virtues:

(1) Its accuracy has become adequate for area targets with high-yield weapons.

(2) Its launch sites can be hardened easily.

(3) It is invulnerable to electronic countermeasures.

(4) It inherently permits simplified simultaneous launchings.

Nevertheless, these points can be countered by the advantages of today's radio guidance:

(1) Accuracy. Radio guidance is sufficiently accurate for hardened point targets using relatively low-yield weapons.

(2) Hardening. Radio guidance sites now can be hardened.

(3) Countermeasures. Jamming of radio guidance is impractical.

(4) Multiple launching. Advanced radio-guidance systems possess a traffic handling capacity significantly higher than earlier systems.

In addition, radio guidance has the advantages of more flexible target selection (even to changing targets in flight), mission recall, and higher airborne reliability.

• **Look at Mistram**—In defense of this argument, we shall describe a radio-command system which offers still better performance in these important areas, and at the same time compares favorably in those areas where inertial systems previously enjoyed certain advantages.

A radio-guidance system typically consists of a ground guidance station and a missile borne beacon. The ground station is capable of determining the position and velocity vector of the missile, and then computing, encoding and transmitting commands which will place the missile in the proper trajectory. The beacon receives and retransmits the signals required for the tracking function and also receives, decodes and acts upon the commands sent by the ground station.

Radio systems, using new techniques, can track the path of a missile with extraordinary accuracy. Such a system is Mistram (*MIS*sile *TRA*jectory *M*easurement System) now under development at the General Electric Company for the Atlantic Missile Range. This missile instrumentation system, which is scheduled to provide the primary range safety and instrumentation on all missile flights out of Cape Canaveral, will illustrate the manner in which radio systems could achieve these accuracies.

Mistram makes use of an old and often-used technique to determine the trajectory of a test missile. The technique involves the use of an interferometer, and utilizes the fact that the point in space at which a signal originates may be determined by simultaneously measuring the relative phase of the signal at three known points.

Mistram differs from previous applications in its ability to perform these measurements accurately over very long baselines (separation between the three known points). This, combined with novel ambiguity resolving and ranging schemes, accounts for its unusual capability.

The basic Mistram ground station consists of three sites arranged in an "L" configuration. The central station houses both a transmitter and a receiver; the outlying stations have receivers only.

The central station transmits two continuous wave signals at different frequencies to the missile. Since these signals are derived from a common source, they have known and controlled phase relationships.

The airborne beacon receives the two signals from the ground, and transmits to the ground two return signals whose phase relationships are controlled with respect to the received signals. Because of this control, both the phase and frequency of the airborne transmitted signals are a direct function of the ground signals, the distance to the ground station, and the velocity vector of the missile.

At the ground sites, the signals from the airborne equipment are received and used to make the interferometer phase comparisons. Doppler measurements also are made on one signal at each of the three receivers to determine the velocity of the missile. To keep the errors low, the electrical lengths of the base lines are measured and the phase data continuously and automatically corrected.

To measure range with this system, a continuous count could be kept on the cycles of Doppler shift from launch, using one of the above signals. While this method can be in error if there is

*(Continued on page 65)*

**The views of these articles are those of the authors, not necessarily those of the Department of Defense.**

*Mr. France is a project engineer over advanced transponder development for General Electric's Light Military Electronics Department, Utica, N.Y.

*Earlier, he was responsible for the entire ground-based radar and communication jamming program for USAF projects at Rome, N.Y.—Air Development Center.

*Mr. Litty, also at GE's LMED, Utica, is a project engineer in Doppler products engineering.*

# ccurate Guidance of ICBM's?

***The Case for Inertial Guidance: Complete self-containment cuts ground installation costs, enhances mobility, provides salvo capability—and guidance during re-entry***

by R. E. Wilson*

## INERTIAL

INERTIAL GUIDANCE has long been attractive from the military point of view, because it is completely self-contained, passive, and nonjammable.

In the past, radio guidance has been favored, largely because of the accuracies which it made possible. However, in the near future, accuracies believed obtainable with inertial guidance will make this the favored approach.

Most of the desirable characteristics which can be claimed for inertial guidance stem from this fact: the system is completely self-contained, and with minimum use of external aids can erect, align, calibrate, and check itself out prior to flight.

Several advantages result. The need for costly ground-based guidance installations, either fixed or mobile, is eliminated. Missiles can be set up and launched rapidly from mobile sites. The number and dispersion of missiles at fixed or mobile sites are limited only by the ability to feed in the desired command requirements. By the very nature of inertially guided missiles, salvo capability is provided.

Attitude reference information is provided during the entire flight. This can be used to simplify the control system during the powered phase to orient the missile for re-entry, and to stabilize during re-entry. Thus, complete re-entry guidance can be provided for maximum-accuracy missiles.

Inertial guidance provides longer positive control capability for maneuvering ICBM's. By storing alternative courses of action in the airborne computer, simple coded radio commands can be used to select any of several targets. Similarly, evasive maneuvers also can be programed.

The inertial guidance system may well provide a reliability advantage when it is considered that each missile is completely self-contained.

Another advantage — price — will become apparent in the future. Complexity and cost of ground-based equipment required by other guidance methods continue to rise. Conversely, the inherent simplicity of inertial guidance eventually will make it the most economical method.

Such present and potential advantages as these have led the military services to invest considerable funds in developing inertial guidance systems. These developments have taken place despite the fact that no less than a dozen years ago most experts asserted that the accuracies which are obtained regularly today were impractical. The accuracies which will be obtained in the future would then have been considered impossible.

The basic sensors of any inertial guidance system are the accelerometers for measuring the three components of acceleration and gyros for measuring the three angular directions. In addition, a missile computer is used for integrating and resolving the acceleration information to determine the instantaneous velocity of the missile. This is compared with a computed desired velocity. The computer then issues the desired control commands.

Let's examine some of the factors which influence the decision as to whether radio or inertial guidance should be employed.

• **Accuracy**—Theoretical studies indicate that both present and future all-inertial guidance systems are not yet approaching the theoretically obtainable accuracy.

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**Mr. Wilson is a consulting engineer for inertial navigation systems in the Armament & Control Section of General Electric's Light Military Electronics Department, Utica, N.Y. He has been responsible for, or served as a consultant on, a wide variety of control and inertial system projects for submarine, aircraft, land vehicle, missile, satellite, and spacecraft applications.*

Inertial guidance at present is limited primarily by the quality of existing gyros and accelerometers. However, a number of new inertial sensors in development show promise of accuracies so much improved that practically pickle-barrel ICBM guidance may be possible.

The major error sources will then be in parameters which are common to both radio and all-inertial guidance systems—location of targets and knowledge of the physical constants of the earth.

The all-inertial guidance system has a major theoretical advantage over radio guidance—its ability to provide re-entry guidance. This could be a major factor, and unless fairly complicated terminal guidance equipment is used to provide target detection capability, the most accurate guidance systems of the future will be all-inertial. If this terminal guidance equipment is used, the accuracies will not be particularly critical for either system.

• **Reliability**—At present, considerable development effort is being expended to increase the reliability of all-inertial systems. The present trend is to reduce the complexity of the inertial sensors and the electromechanical elements and to put more of the guidance task into the missile digital computer.

The tremendous advances in designing small, ultra-reliable digital computers in time will make inertial guidance systems so reliable that this will no longer be a major factor in selecting guidance-system type.

• **Initial erection, alignment and response time**—Inertial systems require significant development effort in order to provide rapid, accurate initial erection and alignment under all tactical situations.

Also involved in the response time is the major problem of warm-up of the components. This can be solved by continual operation of the inertial guidance system, and the initial erection and alignment response time can be reduced

*(Continued on page 68)*

# ARMA Cuts Weight, Adds Reliability

***Experience with inertial system for ICBM produces guidance which company sees as answer for both long- and short-duration missions***

**by Stan Shatunoff***

THE ARMA DIVISION of the American Bosch Arma Corporation is developing an advanced inertial system which promises to satisfy the future navigation and guidance requirements of airborne terrestrial and space missions.

Two years in development, this outgrowth of the *Atlas* ICBM all-inertial guidance system offers significantly lower weight and higher reliability. It is expected to be more accurate in both ballistic-type, short-period guidance missions and long-endurance, cruise or glide vehicle-type missions.

Recognizing that flight of the future will merge the requirements of ballistic missile environment with those of conventional cruise-type navigation, ARMA has heavily emphasized development of miniature gyros, accelerometers, and a flexible, all-transistorized digital computer. The latter will provide the performance demanded of a system that successfully guides a vehicle during boost, through injection, through mid-course orbital or glide flight and into touchdown.

Heart of the system is the four-gimbal inertial platform. The completely integrated platform includes its own electronics—average power required is less than 235 watts.

In terms of mechanical and electrical design, the platform reflects refined concepts evolved from the advanced *Atlas* product improvement program.

• **Single inner bearing**—Nucleus of the platform is an inner azimuth gimbal mounted on a single equatorial bearing. This feature saves space while providing rigidity and maximum accessibility to major components, for easy assembly test and maintenance.

Mounted orthogonally on the azimuth gimbal are three vibrating-string accelerometers—advanced miniaturized versions of the configuration in *Atlas*—and two two-degree-of-freedom gyros which stabilize the platform through the servo-driven isolation gimbals. The two gyro housings and the three accelerometers are rigidly attached to the azimuth gimbal or stable table.

Gimbal servo amplifiers, accelerometer oscillator-amplifiers and gimbal pickoff pre-amps are gimbal-mounted for maximum utilization of space. This technique minimizes slip-ring sizes, as well as external connector sizes and interconnecting cabling.

Other units—such as the proportional temperature control amplifier power supply, and modes control devices—are in an Electronics Uni mounted on the platform housing.

The gimbal system is made up o azimuth, inner-roll, pitch, and outer roll gimbals which provide all-attitud angular freedom for the platform. Th four isolation gimbals are positioned b slaving each gimbal servo to an ap propriate angular pick-off.

The gimbal servos employ two phase, 400-cycle induction-type motor specially designed for high-perform ance, high-temperature operation. Tw motors are used on each axis, mounte in a push-pull geared type arrangement

The selection of this type of geare AC motor rather than a DC torque is based upon tests and experience en countered in the *Atlas* guidance de velopment program. Incremental digita pickoffs are used to measure rotatio of each of the platform's isolatio gimbals. These data are utilized durin the system's ground calibration an alignment phase, in addition to pro viding the guidance system with ve hicular attitude data.

Thermal control of the inertial plat form is achieved by means of a propor tional temperature control system con sisting of:

–A temperature sensor, a platinur

**Technical Staff, ARMA Division, American Bosch Arma Corp., Garden City, Long Island, N.Y.*

## Outgrowth of Atlas Work

*Mockup of inertial platform developed by ARMA. Other cutaway views indicate unique, compact construction resulting in 75% reduction in size.*





sensing element in a precision bridge circuit.

–A temperature control amplifier, a solid-state device which provides control of heater power between 0 and 80 watts.

–Strip heaters suitably deployed to minimize temperature gradients and hot spots.

–Three fans directing the flow of air through the platform.

The two-degree-of-freedom floated gyro (ARMA type G-8) used to stabilize the platform is another design refinement of the gyro already in production for the present *Atlas* system.

Under development since 1957, the new gyro has been extensively evaluated for over 1½ years in vibration and long-term stability tests. Extensive systems and error analyses of boost-glide orbital missions, recoverable orbital reconnaissance missions, 24-hour orbital missions and long-endurance high-speed terrestrial flights have shown that the gyro meets all the reliability, performance and environmental requirements of these tasks.

The accompanying cutaway drawing shows the two floated gimbals used in the gyro. The inner gimbal is a hermetically sealed beryllium sphere which contains the spinning wheel supported on precision ball bearings. The outer gimbal is a beryllium ring surrounding, but not touching, the inner gimbal.

Two degrees of freedom are supplied by thin-elastic centering filaments. One set of filaments connects the floated sphere with the gimbal ring and the other connects the gimbal ring with the outer housing.

Pickoffs detect rotation of the gyro housing relative to the inner gimbal, and torquers process the gyro about each of the two stabilization axes during tests and initial system alignment.

• **Vibrating string accelerometers**—The key component of the platform—the accelerometer—also has been under development for over two years. Although functionally identical to the vibrating-string accelerometer in *Atlas*, the new D-4 is considerably smaller in size and weight, less sensitive to transient and steady-state temperature changes and considerably reduced in its non-linear characteristics. This miniaturized accelerometer represents the knowledge and experience gained during five years of design and production of hundreds of vibrating-string accelerometers.

The measurement of acceleration is accomplished by measuring the reaction to an acceleration force acting on a constrained weight (proof mass). The proof mass is supported within the accelerometer by longitudinal strings and transverse cross supports.

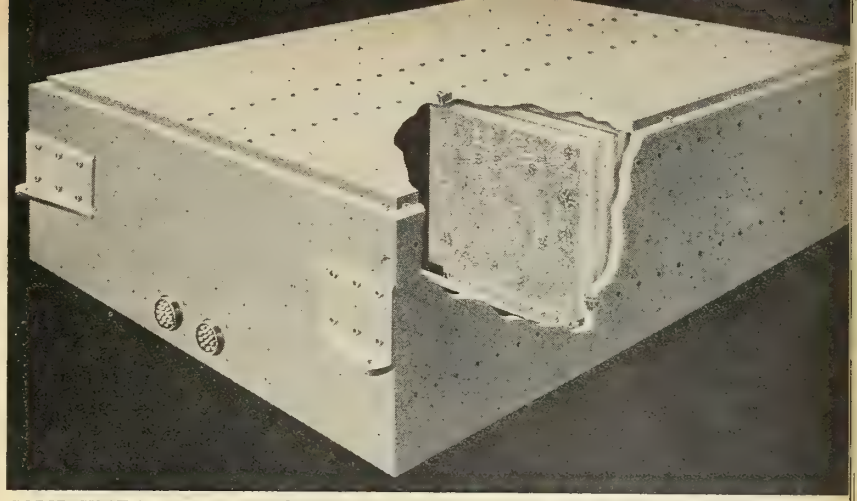
The cross supports prevent motion in a plane perpendicular to the sensitive axis. The component of acceleration force along the sensitive axis changes the tension of the longitudinal vibrating strings: one string increasing in tension and the other decreasing. These changes in tension are measured by noting the changes in the resonant frequency of the vibrating strings.

The all-transistorized electronics portion of the accelerometer system consists of an oscillator-amplifier package utilizing high-density packaging techniques. This package, containing six identical oscillator-amplifiers and a power supply, is mounted on the azimuth gimbal of the stable platform.

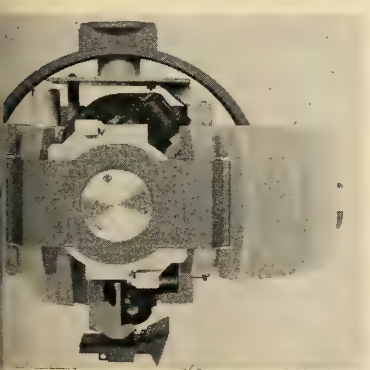
The D-4 accelerometer is designed to operate accurately in the presence of input accelerations up to 20 g and is insensitive to cross-acceleration. ARMA believes its long life and high reliability—due mainly to the complete absence of moving parts, coupled with its exceptionally good long-term stability characteristics—make it an ideal instrument for all future inertial guidance requirements.

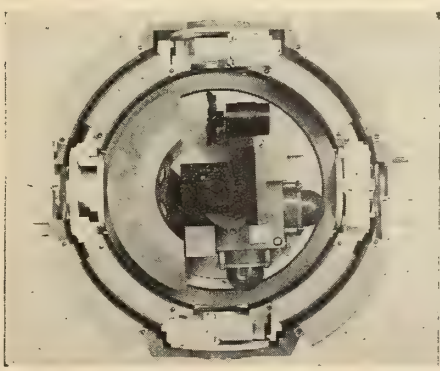
• **Solid-state computer**—The brain of the ARMA advanced inertial system is a lightweight, flexible, all-transistorized digital computer which has no moving parts and incorporates in its design the most advanced fabrication techniques.

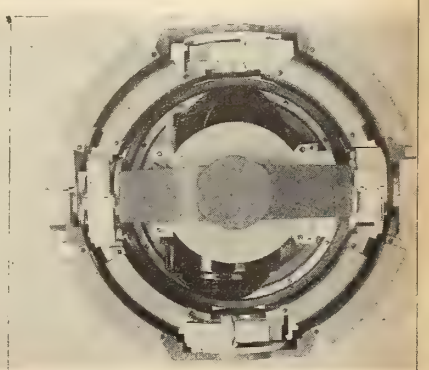
The role of the computer is to accept data from the three platform-mounted accelerometers and the digital pickoffs on the gimbals, and to process this data to yield navigation information and guidance steering orders.



*SOLID-STATE DIGITAL guidance computer is built with honeycomb or labyrinth type of construction to keep size and weight at a minimum.*







## multi-aperture ferrite cores . . .

Since future requirements call for flexibility of computer programing and constants storage, a development program was initiated to evaluate the utility of multi-aperture ferrite cores as the primary computer storage medium. The program has shown that many of the disadvantages heretofore associated with multi-aperture core devices may be avoided by using a "coincident-flux" technique rather than the "coincident current" method usually recommended.

A distinct advantage accrues from employment of the coincident-flux technique, because the cores may be operated over a wide temperature range with very little current-amplitude temperature control.

• **Storage**—The memory unit of the flexible computer consists of 2048 words of program storage and 128 words of working storage.

The program and constants memory is composed of 32 multi-aperture ferrite core planes of 32 rows each. The planes are word-organized with two 16-bit words in each row. Constants, which are 28 bits long, occupy two words in this memory. Read-out from the memory is performed in parallel into the program memory output register.

Constants are read out in two groups, of 16 and 12 bits, respectively, with serial shift out from the output register. A parity check is performed on these constants before they are used in the program.

Address selection in the memory is carried out by the decoding matrix associated with an 11-bit program counter. Five bits specify a plane, five bits a row within that plane and one bit denotes which of the two words within that row is desired.

The working storage consists of four multi-aperture core planes of 32 rows each, with 28 bits per row and an 8-bit shift register. An address in this memory is determined by the information stored in the operand address register, with 2 bits designating a plane and 5 bits designating a row within the plane.

To read information into the working memory, the proper location is addressed and the information to be posted is read into the shift register. It is then written into the memory 8 bits at a time. Similarly, readout from the working storage proceeds 8 bits at a time into the same shift register with serial shift out from the latter.

Other units comprising the computer are:

–Control Unit. It decodes the instruction word, generates computer clock pulses, and controls the transfer of information between units.

–Arithmetic Unit. A separate multiplier-divider allows for simultaneous use of the accumulator for subtraction and addition while the slower operation of multiplication or division is being performed.

–Input Unit. An autonomous input unit collects accelerometer, gimbal angle data, and other information for use by the computer at programed intervals.

–Output Unit. Digital displays and digital-to-an-analog conversion is performed in this unit.

The Control Unit contains switching and logic circuits for the generation of special conditional gates, the control section for the transfer of information to and from the Arithmetic Unit Accumulator, and the necessary logic for the direct transfer of information to the multiplier-divider, and from the product output to and from working storage. The Control Unit contains the timing generator, the program Memory Output Register and the program counter.

The Arithmetic Unit can perform 1000 multiplications or 275 divisions in one second, simultaneously with 8000 addition or subtractions. It consists of an adder, a multiplier-divider, a sign determination circuit, an accumulator register (independent of the multiplier-divider) and a 2's complementing circuit.

The Accumulator includes a full adder, a magnetostrictive delay line register, and logic to control the operations of addition, subtraction, absolute value, logical "and," shift left, and shift right. For subtraction and absolute value operations, the 2's complement notation is used.

The Input Units can accept accelerometer data, roll, pitch and yaw data, and program and launch condition information provided from an external tape unit. The Output Units provide continuous data in both analog and digital form, in addition to a variety of discrete signals such as engine cutoff, malfunction indication, etc.

In this computer, the word—or basic unit of information—may represent numerical data or a computer instruction. Numbers are stored in binary fixed point, fractional notation. A 2's complement is used to represent negative numbers. Numerical data in the working storage consist of 27 magnitude bits and a sign bit.

The binary point is normally considered to be the left of bit position 1, i.e., all numbers are less than unit. However, as in all fixed point computers, the programer may, by proper sealing, place the decimal point anywhere in the number.

Instruction words are 16 bits in length, and are of a single address type. The operation portion of the word contains the binary representation of the command to be executed: e.g., add, subtract, multiply.

The operand address contains the address, in binary notation, of the memory location where the numerical data to be operated upon is stored. It may also represent the number of bits involved in a shift command.

There are 25 commands which can be executed by the flexible computer, and each command normally requires a fixed number of word times. (There are 8000 word times per second.) However, the execution time of certain commands may be extended up to 7 word times by storing the desired delay time as part of the command word.

Within the computer are 38 subassemblies, the transfluxor memory and several power supply components. All necessary external cable connections are available at the front of the computer.

•**Weight down**—Minimum weight is obtained, without sacrificing reliability, by a packaging technique in which the individual subassemblies are first designed to contain a minimum of support structure, and then integrated into a unified package. This generates a rigid high-natural-frequency honeycomb or labyrinth type of construction.

Lightweight materials are used which, for the given application, are outstanding in their strength-vs.-weight, or stiffness-vs.-weight properties. Extensive use is made of plastics, foams and magnesium extrusions.

The computer can be readily produced in large quantities with a minimum of skilled personnel. To achieve this objective, the computer has been modularized to as many similar or identical pieces as possible. These subassemblies or modules are, in themselves, simple to fabricate and lend themselves to assembly line techniques.

The optimum size of module to be used has been considered by studying the "trade-off" on module size, number of different modules, total number of components to do a particular task, total number of solder connections required, and necessary quantity of interconnecting cabling. Eight-five percent of the computer circuitry is complemented from 10 standardized modules.#

# Titan II All-inertial System to be Tested Soon



*FINAL CLEANING of a small gyro float used in Titan II inertial platform is performed in a lint- and dirt-free pressurized cabinet at AC Spark Plug.*

**by Dr. Joseph Shea**

*Titan II Guidance Project Manager, AC Spark Plug Division, General Motors Corp., Milwaukee.*

TITAN II's highly advanced all-inertial guidance system will be test-flown before summer, 1961.

Initiated in 1959, when the contract was awarded to AC Spark Plug Div. of General Motors by The Martin Co., the system has been developed in a remarkably short period of time.

It had to be, for *Titan II* is scheduled to be operational by early 1963.

• **Inertial systems mature**—Design problems in the guidance of ballistic missiles have ceased to be a question of accuracy alone; they now focus on the operational advantages of one system over another. In the early days of the U.S. ballistic missile program, when guidance accuracy was considered the limiting factor in weapon system effectiveness.

In retrospect, the problem has not been as difficult as first estimated. The electronic industry has responded in each development undertaken with a system which meets all of the accuracy requirements of operational ICBM's.

In 1955 the advanced state of radio technique—monopulse, Doppler, interferometer—led to extensive development programs in these areas to satisfy the guidance requirements of our first operational squadrons. Inertial systems, attractive as they were operationally, had barely come out of the laboratory and were not considered good developmental risks.

The strides made during the last five years in the inertial field have been stupendous. Paced by the development of the inertial system for the intermediate-range *Thor*, which demonstrated both the practicability of inertial guidance for ballistic missiles and the producibility of the equipment, most operational U.S. ICBM's soon will be committed to inertial techniques.

One of the major programs is the development by AC Spark of the inertial guidance equipment for the *Titan II* vehicle.

• **Descendent of Skipper**—The *Titan II* guidance system is a second-generation inertial system. The instruments used are more than adequate to assure accuracy.

Major emphasis in the system design has been operational utility, simplicity, reliability, and maintainability. In addition to the normal operational advantages of inertial equipment, the system will provide essentially an instantaneous reaction time, plus automatic installation, checkout and malfunction detection.

The system will be maintained continually, kept in a state of readiness, with continuous evaluation of both gyros and accelerometers. Recalibration of the instrument to maintain specified performance can be done automatically. The black-box concept of maintenance provides easy replacement and repair with minimum operational personnel.

In addition to providing the guidance function, the missileborne system will be used as attitude reference for the vehicle, thereby incorporating the conventional autopilot function into the guidance system. The missile will be under positive guidance control from launch to cut-off.

Both the instruments and the inertial package are outgrowths of the "Skipper" program conducted at MIT under Air Force sponsorship. The effective working relationship between MIT and AC Spark has enabled the Skipper platform to evolve into an operational ICBM guidance system in a remarkably short time.

Although many details of the *Titan II* guidance system and its accuracy are classified, a general description of the equipment can be provided.

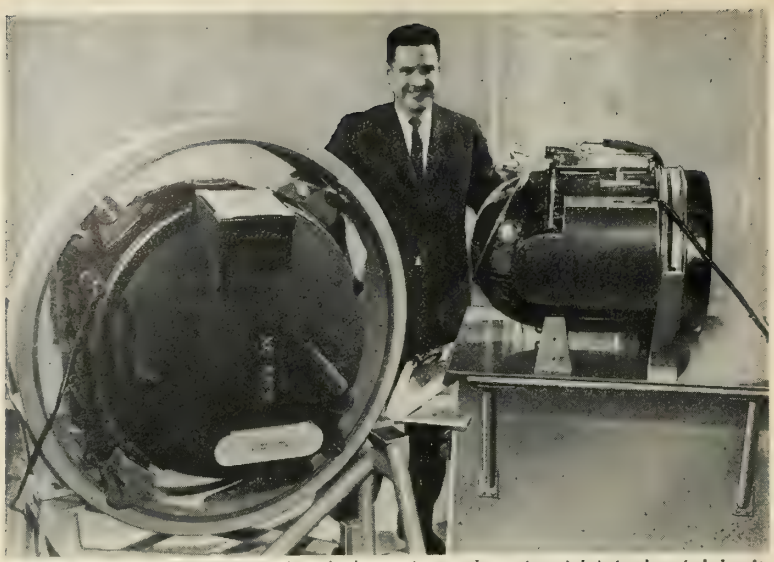
To meet weapon system requirements for the *Titan II* missile, an inertial guidance system was required.

Among the advantages that an all-inertial guidance system presents to the weapon system are fast reaction time, minimum ground operating equipment, invulnerability to jamming devices and the capability of salvo launch.

The requirements placed upon the guidance system by the weapon system requirements include high reliability, automatic malfunction detection and semiautomatic malfunction isolation, maximum ease of replacement and repair with minimum operational personnel, operation from a hardened silo, and, of course, pin-point accuracy.

• **Platform and electronics**—Two pieces of inertial guidance equipment will be mounted in the bird: the inertial measurement unit (IMU) and the missile guidance computer (MGC). Heart of the guidance system is the stabilized platform contained inside the gimbals of the IMU. The platform is slaved to an earth-fixed set of axes prior to launch, but maintains an inertially fixed orientation during flight.

The platform mounts stabilization



*COMPLETE TITAN II inertial and electronics package (at right) is dwarfed by its predecessor, the Thor IRBM guidance platform, shown here without its pallette of associated equipment. Dr. Joseph Shea, author of the accompanying article, directed the Titan II project for AC Spark Plug Division.*

gyros, integrating accelerometers, a vertical sensing element, a porro prism and a fluid temperature control system. The 2FBG (floated, single-degree-of-freedom, beryllium) gyros and the PIGA (Pendulous Integrating Gyro) accelerometers manufactured by AC are used in the platform basic design developed by Massachusetts Institute of Technology. These units—of conventional, conservative design—have demonstrated performance necessary to assure high accuracy.

The stabilization gyros are used to sense angular motion, and, through its associated servo loops, control the gimbals to maintain the platform in its stable position. The accelerometers sense any linear acceleration, convert this into velocity increments and put out digital velocity information to the missile guidance computer. The digital outputs emanate from a transducer incorporated within the accelerometer.

The vertical sensing element, commonly called a pendulum, is used as a vertical reference for the erection of the platform. The porro prism is employed to reflect a beam of light back to an electro-theodolite set to establish the azimuth reference during erection.

Key to performance of an inertial system is temperature control. In order to improve control of both absolute temperatures and the gradients through the instruments and platform, a fluid is circulated through the accelerometers, gyros and platform.

The fluid temperature is controlled to a fraction of a degree in a central heat exchanger. This system provides a degree of control unattainable in systems using air.

In addition to measuring missile motion, the platform is used as an attitude reference for the vehicle, thereby eliminating the conventional autopilot reference package. A transducer mounted on each gimbal axis furnishes digital missile-attitude information to the computer.

This entire gimbal package is combined with a cylindrical electronics package which contains the power supplies and servo amplifiers to operate the stabilization and accelerometer servo loops. The electronics package is mounted on a heat sink and air conditioning is supplied to the IMU during ground operation.

The electronics packages are manufactured utilizing the welded encapsulated module (WEM) technique. All electrical connections are welded rather than soldered to meet high reliability requirements.

The entire IMU weighs less than 200 pounds.

• **Computer controlled**—The digital outputs from the accelerometers and gimbal angle transducers are the inputs to the missile guidance computer. The computer is a serial, binary, whole word, programable machine manufactured by the Federal Division of International Business Machines Corporation. A magnetic drum is utilized for both permanent and temporary storage.

The computer combines the transducer data with pre-stored target and IMU characteristics data to supply outputs to the missile control system. These outputs consist of the steering signals for roll, pitch and yaw control and a series of discrete signals commanding engine cutoff operations. The programing function is also handled by the computer.

The drum is mounted in the center of the computer and is surrounded by panels containing the digital circuitry. This circuitry, too, is welded and is packaged in "logic sticks."

• **Alinement and checkout**—Guidance alinement and checkout console and an electro-theodolite set comprise the directly associated ground support equipment. The console is a four-bay unit containing all the equipment required to furnish power, erect, and maintain the missileborne equipment in its readiness condition.

It provides comparators necessary for automatic fault detection, and the logic required to isolate the fault to a replaceable panel. The console also mounts the punched-paper tape equipment necessary for loading target information into the computer.

Test capability is included to periodically exercise the entire system for preventive maintenance purposes.

The electro-theodolite set is mounted in the silo wall so that it has a direct line of sight to the porro prism on the inertial platform. It contains a reference porro which is used as a transfer device to a first-order reference established at ground level.

The error signal generated by the theodolites is used by the erection servos to align the platform and maintain it at an exact aximuth.

The system is interconnected with the launch control center so that the launch control officer remotely can control and monitor the guidance system. The system is designed to monitor itself automatically for readiness capability during normal operation. The alinement and checkout console and the missileborne computer combine to furnish this capability.

If an accelerometer scale factor should change by a specified amount, or if gyro torquing current should vary, the system will detect the change and recalculate the required compensation. The new compensation will then be stored in the computer without operator handling.

At lift-off, the guidance system—stabilized in inertial space—proceeds to steer the missile through staging to final engine cut-off in such a way that the payload will follow its ballistic trajectory to eventual impact at the target.

Evaluation of the *Titan II* inertial guidance system consists of a series of in-plant operational and environmental tests, as well as field test programs on the rocket-sled track at Holloman AFB, N.M., at Cape Canaveral, and at the Pacific Missile Range. ⌗

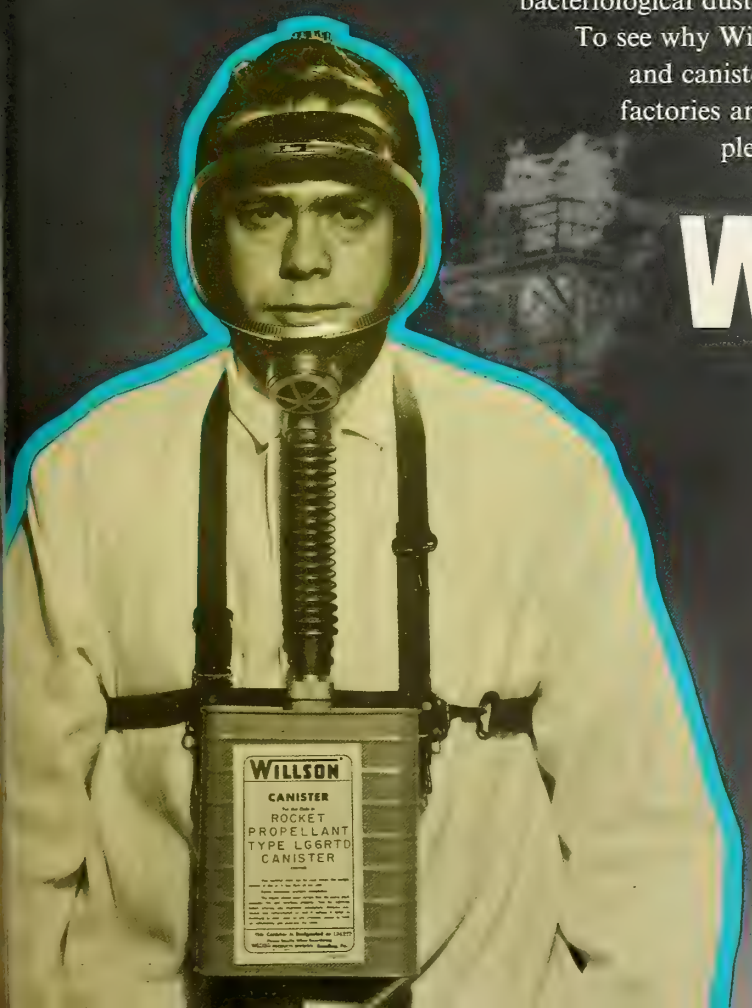
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TITAN, ICBM, MARTIN COMPANY

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*please turn the page*

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GUIDANCE / MINUTEMAN

*PRODUCTION WORKERS at Autonetics at work on detailed wiring for Minuteman's solid-state digital guidance computer. Note relative size of cylindrical unit. Computer guides bird, checks calibration and alinement during storage.*

# Minuteman System Is 'Most Reliable'

## *Long stand-by requirement imposes special demands not applied to other ICBM's; Feb. 1 firing demonstrated accuracy*

**by Rolf Winterfelt***

EXTREME ACCURACY, high reliability and storability, and relatively low cost are the primary design characteristics of the Air Force's new *Minuteman* ICBM guidance system.

The inertial guidance system for *Minuteman* has to be reliable beyond the state of the art of other such systems. Such a severe design requirement was mandatory because the missile must be capable of dependable operation after long stand-by periods.

It has been only a short time since the first production-type inertial guidance system for *Minuteman* was accepted by the Air Force from Autonetics Division of North American Aviation, Inc., associate prime contractor for the missile's guidance and flight control. On Feb. 1, 1961, this completely integrated system was in control of the first *Minuteman* flight, —a 4200-mile trip down the Atlantic Missile Range and reportedly well within the target area.

Since then, even more advanced *Minuteman* guidance systems have been delivered and integrated into the missile.

Development of inertial instruments has progressed to the point where they can now provide precise information for calculation of position and velocity and control of a missile. Such inertial guidance is particularly desirable in ICBM's, since it is self-contained, not detectable and jam-proof.

• **How system works**—Autonetics' N10 inertial guidance system uses a three-axis gyro stabilized platform holding three induction-type velocity meters mounted on a single frame.

The velocity meter is a single-integrating device; this is mechanized by balancing the acceleration responsive torque on a floated pendulous proof mass, with the eddy-current induction torque created by a rotating constant-intensity magnetic field.

The pendulous proof mass consists of a metallic induction disk, supported eccentrically by means of a hydrodynamic bearing and a position pickoff which senses electrically any rotation of the pendulum resulting from applied torques.

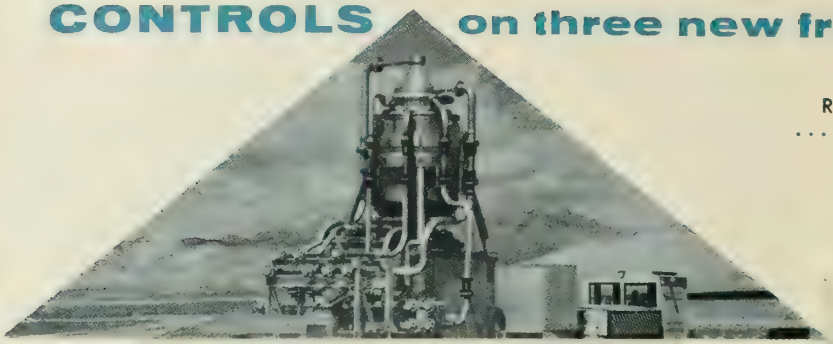
The pick-off signal is amplified and operated on by the servo controller, and the resultant output of the latter excites the magnet-drive motor in such a way that the rotation velocity of the magnets induces an eddy-current drag torque on the induction disk to balance the applied torque due to acceleration. The angle through which the magnets have rotated during a specific time interval is, then, a measure of the time integral of the acceleration along the sensitive axis. This angle is sensed by the output resolver attached to the magnet shaft.

Low cost and producibility are features of this extremely accurate instrument. It offers the particular advantage of having no high-speed rotating parts except under flight accelerations, so that it can be operated for long periods of stand-by on the ground without significant wear.

The stable element subsystem includes the inertial components (gyros

*Project Engineer, Minuteman Inertial Guidance, Autonetics Division of North American Aviation, Inc., Downey, Calif.

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nd acceleration-sensing devices) and n alinement set. The electronic pack-ge, consisting of tuning and bridge esistors and amplifier switching elec-ronics for the bubble levels, is also ocated on the stable element.

The gimbal structure provides the ecessary degrees of freedom of the table element relative to the airframe f the missile. The platform axes are ept parallel to an earth-fixed, launch-oint-level, coordinate system, with one xis orientated in the approximate di-ection of the target.

• **Simplified gyros used**—The free-otor gyro is a simple device with a minimum number of components, as ompared to conventional floated gyros. The gyro is of minimum size and veight, quick warm-up, and adaptability or extensive use under conditions im-osing a minimum of handling and djustment.

Two free-rotor gyros, each of whose otors spin on a spherical, self-lubri-ated gas bearing, provide complete at-itude references for the inertial plat-orm.

Many of the problems encountered n a liquid-floated gyro—such as con-ection currents and buoyancy effects, eakage and pump difficulties—do not xist with the free-rotor gyro. Tempera-ure effects are small, thanks to the bsence of motor laminations and ball earings; high rigidity of the rotor is ttainable.

Since the rotor is completely non-nagnetic, stray magnetic torques are liminated. Vibration and bearing noise an be made practically nonexistent vith gas spin bearings and, since no vear occurs with such bearings, high eliability and long life are possible. The gyros can operate continuously for nany years without wear or per-ormance degradation.

• **Calibration and alinement**—Fully utomatic calibration, bias setting and linement are achieved through a very dvanced concept. An alinement unit s mounted on the stable element, con-isting of four level detectors on a ingle mounting block. In addition, hasing networks and preamplifiers are art of the alinement set.

The level detectors furnish informa-ion permitting the stable element to e accurately leveled in any of four recisely related orientations. One of hese is the flight attitude; the other hree are used for calibration purposes.

The alinement unit, together with roper programing of the computer, is ufficient to set the biases, calibrate the nertial instruments and aline the sys-em. Azimuth alinement is accom-lished with an autocollimator.

• **General purpose computer**—The irborne digital computer, which plays n important role in the overall inertial



*SURE HANDS and dust-free cleanliness are vital in assembly of Autonetics gyro float for inertial navigation.*

guidance and flight control system, is an all-transistorized, general-purpose device. It operates in serial mode and uses a rotating disk-type memory for data storage.

Advanced transistor circuits and packaging techniques are used to make the computer a miniature versatile unit. The semiconductors are silicon and mesa-germanium-type devices which have very reliable high-temperature characteristics.

An internally-stored program operates the computer, which is filled from punched tape, control panel keyboard, or other input filling devices. The computer accepts information from the velocity meters, angular accelerometers and platform gimbal pickoffs. It uses this data to generate stabilization and steering signals, as well as staging and thrust termination signals. The computer solves guidance equations and flight control equations and supplies prearm signals to the re-entry vehicle.

It also has a number of other uses in the *Minuteman* system. Flight command signals from the computer are transmitted to the nozzle control units, where the appropriate nozzles are moved to direct the thrust vectors of the engines. By continual adjustment of these thrust vectors, the missile is stabilized in yaw, pitch, and roll on the proper trajectory.

Another use is in automatic calibration and alinement of the missile's guidance system at periodic intervals during the ICBM's "ready" life in its silo. By means of a program stored in the computer memory, the settings of the guidance gyros and velocity meters are periodically checked for calibration and alinement. If errors are found, the computer automatically takes corrective action. Following completion of the check, the missile guidance system is ready for instant use.

• **New reliability techniques**—In the *Minuteman* N10 system, the gyros, velocity meters, structural design, automatic alinement procedures and system reliability represent advances in present-generation inertial equipment.

New techniques were developed in using electronic components in the system and controlling the processing of these components in such a way that reliability goals required by *Minuteman* can be met. This called for reliability programs at each of the component manufacturers; at the same time, special handling, marking, testing and burn-in under stringent controls had to be implemented at Autonetics. Emphasis is being placed on reliability, light weight, and ease of maintenance.

Assembly of electronic modules in dust-free areas, and instruction and training of the personnel by means of closed circuit television, are part of the Autonetics reliability program.

The successful tests of early inertial guidance systems indicate that the high-reliability effort now underway at Autonetics and its subcontractors is effective.

System components have been standardized, minimizing the number of different parts. The inertial guidance system uses no potentiometers or relays; all components are electronic. Failure analysis reporting systems and recurrence control are being improved and perfected to assure that detected problems can be solved early in the program.

Special analysis of circuits continues, and engineering changes are incorporated to assure increasing reliability. Electronic components are identified and marked. Special records are kept to follow each component into the final hardware.

When component failures occur, the components can be traced back to a particular manufacturing batch and process. It is possible in this way to identify a bad process, poor materials or insufficient training of personnel at the component vendors.

Seldom before in the use of electronic components has it been possible to keep historic records of all electronic components in an assembly, and to control the product by closing the loop of information back to the component manufacturers and the process by which they were developed. Efforts to simplify the system have improved producibility, operation and maintenance concepts of the weapon system.

Autonetics' efforts are expected to aid the entire military and industry. ⌘

GUIDANCE / SATURN

# NASA Ready to Pick Saturn System

## *Marshall Center and JPL in disagreement over which is best approach*

by Jay Holmes

IN THE NEXT few weeks, the National Aeronautics and Space Administration expects to make a series of major decisions on the nature of the *Saturn* guidance system and who is to produce it.

Plans until now had been to produce the system at NASA's Marshall Space Flight Center, Huntsville, Ala., and procure major subsystems and components from industry.

Now, however, there is some consideration of assigning the entire guidance development task to a prime industrial contractor.

Also up for decision is the question of just what kind of guidance system will be aboard the *Saturn*, which carries America's hope for bettering the Soviet Union in launch vehicle power by 1964 or 1965. In part, the question revolves around a jurisdictional question that has developed between two NASA agencies, the Marshall Center and Jet Propulsion Laboratory.

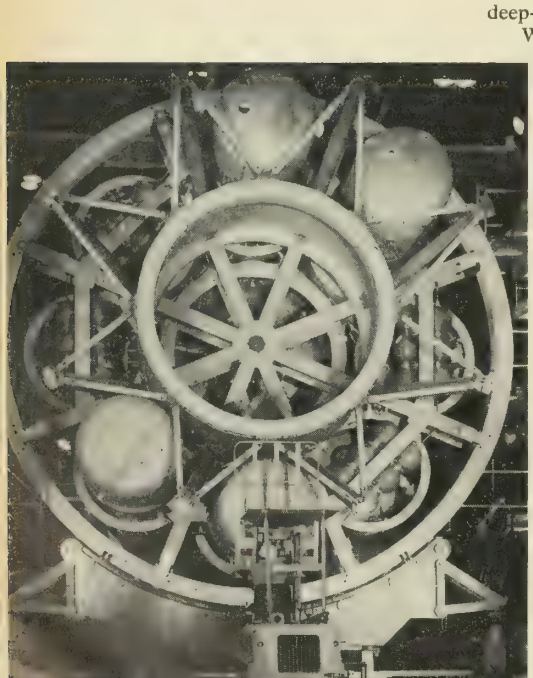
Marshall is responsible for developing launch vehicles and, along with that mission, for guiding vehicles up to the time when they are injected into orbit. JPL is charged with developing spacecraft for deep-space missions—such as to the moon and the planets—including the guiding of spacecraft on deep-space trajectories.

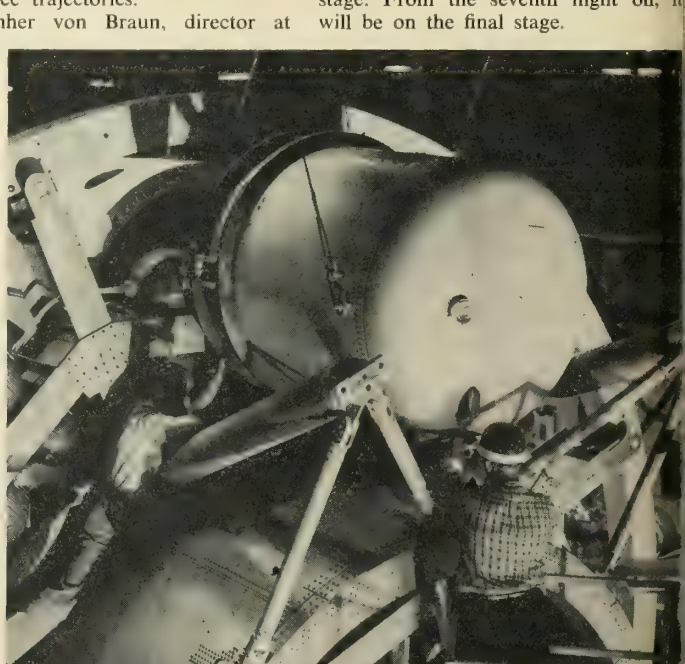
Wernher von Braun, director at Marshall, contends it is wasteful to use a guidance system—including an extremely sophisticated computer and other components—just for carrying a space vehicle up to the point of injection into a deep space trajectory, and then fail to make further use of it.

JPL spokesmen have not commented publicly on the question. However, it is understood they feel that guidance in deep space imposes special requirements that are not best met by systems designed for launch vehicles.

• **Upward progression**—During the test phase of the *Saturn* vehicle, the guidance package will be moved upward as live stages are added. *Saturn* is scheduled to have 10 flight tests between 1961 and 1964. The first three will be live boosters with dummy second and third stages. Next will be a series of live boosters with live second stages consisting of the S-IV LOX-liquid hydrogen vehicle being developed by Douglas. Then will be a series of tests with three live stages, by adding the S-V modified *Centaur* vehicle, being developed by Convair. *Saturn* 10 will be a prototype operational vehicle.

In the first three flights, the guidance package is to be carried in an adapter ring atop the first stage. On the next three, it will go onto the second stage. From the seventh flight on, it will be on the final stage.





**LEFT:** *Workman installs one of four guidance-telemetry packages on flight Saturn.* **RIGHT:** *A closeup of the package, four feet in diameter and 4½ feet long, which will monitor engine performance and signal necessary swiveling of outer four engines.*

On the early flights, guidance will be combined with an extensive telemetering package, to monitor engine performance. The equipment will be installed in four cylindrical capsules roughly 4 ft. in diameter and 4½ ft. long.

Many fundamental features of the control system of *Saturn* will result from adapting components used in the *Jupiter* to meet the needs of the bigger vehicle. However, rate gyros will be added as sensing elements—a major departure. The big *Saturn* vehicle is somewhat flexible and may bend under stress. Rate gyros will make it possible to do a better job of stabilization.

• **Prime goal**—The *Saturn* guidance itself has the major objective of providing a universal system capable of performing many mission requirements in support of payload objectives, *Saturn* Systems Chief Oswald H. Lange says. Guidance will be all-inertial.

The first responsibility, of course, will be to monitor and correct performance of the eight engines of the booster stage. Four of the engines will be mounted solidly in a central square. The remaining four, on an outer ring, can be swiveled to correct the flight trajectory.

The control information will be active on all flights. If one engine goes out, propellant will be distributed to other engines.

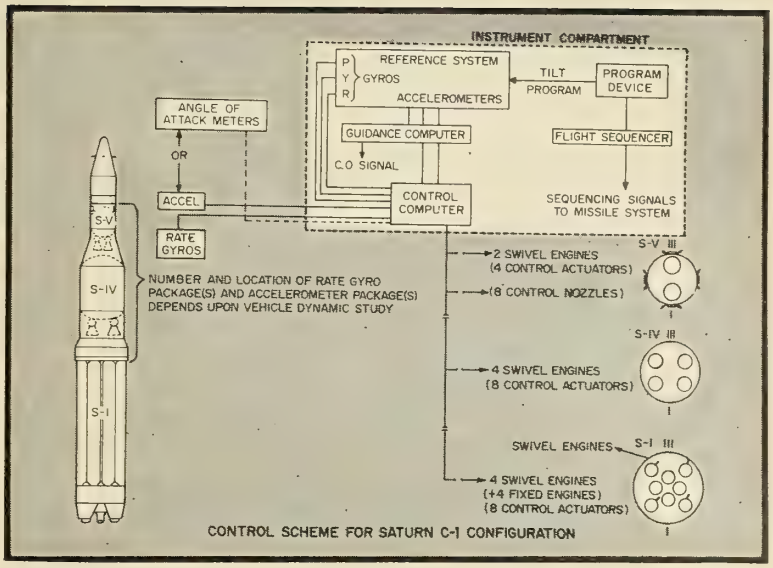
However, on the first three flights the *Jupiter*-type platform will be active only for engine control information. Guidance information will be telemetered back to ground stations.

• **There'll be some changes**—Regardless of the decisions taken in the next few weeks, it seems certain that some sort of advanced guidance system will be aboard in later flights. The nature and timing are up for decision.

Early in January, before NASA decided to review the entire *Saturn* guidance question, Walter Haeussermann, chief of the Marshall Center Guidance and Control Division, said a simple guidance computer was to ride as a passenger on flights 4-6, telemetering data back, and become active on flights 7-10.

Under the old plan, an advanced form of stable platform was to ride as passenger on flights 4-10 and become active with flight 11, the first operational *Saturn*. The same plan was envisioned for an advanced, highly sophisticated guidance computer. If the entire package were not ready by flight 7, the idea was to start flying components then and work up to an entire system as soon as possible.

The early *Jupiter*-type inertial guidance unit is manufactured by Sperry-Farragut Division of Sperry Rand. The gyros are standard, air-suspended units with one degree of freedom. The inertial elements are fully gimballed. Control information is provided by yaw, pitch and roll accelerometers. Corrections are made through a hydraulic system powered from a gas turbine.



CONTROL SCHEME FOR SATURN C-1 CONFIGURATION

• **Outside gimballing?** — An advanced system under current study has the goal of greatly reducing size, weight and power requirements. For greater flexibility, Hauessermann said, it should be outside-gamballed, so as to allow much more angular freedom than the *Jupiter*-type, intended primarily for a ballistic missile.

The Marshall guidance chief foresaw the likelihood of early mid-course guidance in the third stage, followed by radio vernier control of the spacecraft on deep-space missions. However, NASA headquarters may decide that is part of the JPL mission.

Under the old plan, the first two stages of *Saturn* were to yield to early perturbations of wind and thrust, except to swivel engines for control. With three live stages, the first corrections of the flight course itself were to be made after second-stage burnout.

On the first-stage tests, eight *Pershing*-type telemetering transmitter packages, each about 1 cu. ft. in volume, will be used with 216-channel multiplexers to combine signals from about 600 transducers and other sensors. With live second and third stages, 700 to 1000 different measurements will be made during each flight. Haeussermann figures the cost of this part of the program at about $600 a measurement.

In January, two types of computers were under study for the job of providing a high-speed digital system for both guidance and control. One, by International Business Machines, is a small, somewhat advanced solid-state system like that IBM supplies for *Titan II*. The other is a more conventional computer Librascope is supplying for *Centaur*. One of the two was to be carried as passenger of flights 4-6 and become active on flights 7-10.

The plan was to award contracts in late 1961 for study of the advanced digital computer, which would use advanced solid-state concepts, have enlarged capacity and be greatly reduced in size. The aim would be for extreme reliability.

The computer would not give separation instructions to the *Saturn* booster. Separation was to be accomplished instead by programed timers connected to fuel-level sensors.

Power would be supplied to the guidance and control system from batteries and a 1-kilowatt rotary inverter. A static inverter and battery pack are in development. The guidance and control equipment will use less than 750 watts, leaving 250 watts for the telemetry and hydraulic measuring units. A hot-gas turbine will provide power for hydraulic control actuation.

The first-stage telemetry package is being developed by Motorola. National Data Systems Inc., Dallas, is supplying the 216-channel multiplexer.

In the second stage, sub-contractors for Douglas on electronics include Applied Science Corp., Princeton, N.J.; Electro-Mechanical Research Corp., Sarasota, Fla.; and Bendix. ⌗

# X-15 Flight Data System—A Precursor

***Sperry inertial instruments supply control information to the pilot—vital during critical high-altitude and high-velocity flight***

**by John F. Judge**

THE FORERUNNER of future aerospace vehicle flight data systems directs *X-15* pilots as they put the rocket plane through its paces.

An inertial all-attitude flight data system, designed and built by Sperry Gyroscope Co., division of Sperry Rand Corp., provides the pilot with the information necessary to control the craft at speeds up to 4000 mph and altitudes of 100 miles.

Each component—and the entire system—can withstand accelerations of more than 10 g and function perfectly in weightless environments.

In addition to supplying inertial information for the cockpit instruments, the system's sensors and computer feed data to specialized airborne and ground recorders.



*EXTREME ACCURACY and reliability of the X-15 inertial system was determined on this "stable table" set-up. The system is designed to operate within the X-15 in conjunction with four flight instruments which aid in the piloting.*

Four general types of instrumentation were originally considered by Sperry for the North American *X-15*: pressure instruments, radar or radio, simple gyroscopic and inertial.

The inertial system was the only one that could handle all the required measurements of velocity, altitude and attitude angles. In addition, the single limiting factor inherent in the inertial system was its flight duration. But it was possible to develop inertial components adequate to the mission of the *X-15*—an operating life of 1000 hours.

• **Twin functions**—The *X-15* Inertial All-Attitude Flight Data System can be functionally divided into two groups. One section is carried in the *X-15* itself and consists basically of the stabilizer, computer and indicators. This equipment supplies all of the required data after the *X-15* is launched.

The second group is carried in the B-52 launching aircraft. This equipment is used to supply the proper initial conditions to the computer and thus align and stabilize the platform prior to launch.

The data insertion equipment was located in the B-52 to save overall weight in the rocket plane and to relieve the *X-15* pilot of any duties in the pre-launch phase.

The inertial system is composed of the stabilizer, which contains the sensory elements, and the computer, which processes data from the sensing elements to derive velocity, position and altitude data.

The platform is maintained normal to the geographic vertical and, because of the extreme altitude and velocities of the plane, all accelerations due to kinematic velocities and changes in the earth's mass attraction are computed and inserted into the system.

• **Gimbal complex** — Four distinct axes of rotational freedom are present in the stabilizer. The sequence of rotational freedom from the case inward are roll, pitch, inner roll and azimuth. The pitch, inner-roll and azimuth axes are mutually perpendicular. The outer roll axis is gimballed with respect to the fore-aft aircraft axis and operates

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*HOT NOSE DEVELOPED by Northrop's Nortronics Division senses angles of attack and side slip during exit and entry phases of X-15 flight.*

in conjunction with the inner-roll axis to produce an angular displacement proportional to aircraft roll attitude.

The redundant roll axis allows the aircraft unlimited maneuvering about any degree of freedom without the possibility of gimbal lock or loss of verticality.

Basically, the gimbal design consists of direct-drive torquers and single-speed readout synchros mounted at each end of slightly elliptical gimbals. The servo amplifiers for each axis are transistorized and mount directly on the gimbal being driven. The gimbal itself is used as a heat sink for the power transistors, reducing the number of required slip rings.

The torque capability of each gimbal axis torquer varies between 1½ lb.-ft. for the outer-roll axis to ¾ lb.-ft. for the inner-roll and pitch axes. The azimuth axis requires a smaller torquer, 0.3 lb.-ft., because of lesser dynamic requirements.

This design approach essentially eliminates gearing on the gimbal axes and has the advantage of minimizing disturbance forces acting on the platform under flight conditions. It also enhances performance under vibration.

The gimbal servo response is on the order of 40 cps, since design limitations usually caused by shaft flexure and gear backlash are essentially eliminated.

Sperry says that isoelasticity was a prime consideration in the gimbal structure, and a symmetrical gimbal design resulted from this as well as from space and weight factors.

• **Platform assembly**—Three linear accelerometers and three integrating gyros form the sensing elements mounted on the platform. Ten transistorized amplifiers are required to operate the sensing elements and the gimbal servos.

Three $10^{+5}$ gm-cm²/sec. floated rate-integrated gyros are used with associated heater amplifiers to maintain the operating temperature within narrow limits. A Sperry linear accelerometer is employed.

This consists of a test mass, a capacitive sensing element and a force balanced servo amplifier. The output of the instrument is a DC current proportional to acceleration. The threshold is better than $10^{-5}$ g and its accuracy without calibration is of the order of $10^{-4}$ g.

The case design consists of two concentric shells with a corrugated surface. These corrugations considerably increase the area of heat conduction from the platform air to the external cooling air. Thus the case configuration serves as a heat exchanger.

The computer performs the functions of Doppler inertial mixing, gyro drift storage, acceleration-to-velocity integration, velocity-to-position integration, earth-rate computations and acceleration corrections due to kinematic velocities. System noise and weight are kept to a minimum, by means of DC analog computing techniques.

The computer uses two basic computing blocks. One is a precision integrator that utilizes a Sperry DC tachogenerator as the fundamental accuracy-determining element. These integrators are packaged in two groups of three each, with all necessary electronic equipment included. This arrangement simplifies maintenance and test procedures.

Similar packaging concepts are used with the second computing element, an integrator used to erect and align the platform. The acceleration corrections and earth-rate computations are accomplished passively with resistor networks and potentiometers.

The computer is connected to the control panel in the B-52 mother plane. The panel performs system mode selection, manual insertion of initial altitude and position data and system performance monitoring prior to launch.

It also contains the converters and couplers necessary to introduce the initial velocities and heading angle into the system for alignment purposes.

Within the *X-15*, the inertial system is designed to operate in conjunction with four flight instruments which aid in the piloting. Three of these instruments were specially designed for the *X-15*; the fourth is a three-axis attitude indicator.

One of the special instruments is a self-contained altitude indicator operating on synchro data from the computer. The other two are a vertical velocity indicator and a total velocity indicator.

The vertical velocity indicator is used during high-speed, level runs. It is a simple meter-movement type instrument. The total velocity indicator is a computing mechanism which receives the three components of the velocity from the *X-15* inertial system, derives and displays total vector velocity. ⌗

# Dyna-Soar to Depend on Proven Parts

## *Honeywell is developing primary subsystem for boost-glider and producing flight controls for space vehicle*

by Paul Yingst
and
Charles L. Seacord*

ENTIRELY TRIED and proven hardware is the byword for *Dyna-Soar's* guidance and control system selection.

*Dyna-Soar*, a manned, delta-winged glider boosted into orbit by a modified *Titan II*, must be able to re-enter the atmosphere and land at any suitable airfield chosen by the pilot within a circle of maneuverability several thousand miles in diameter.

Its range of speeds will extend from over 15,000 miles an hour in orbit down to a landing speed of less than that of some of our present combat aircraft.

Minneapolis-Honeywell Regulator Co. recently was named an associate prime contractor by the Air Force Aeronautical Systems Center, Dayton, Ohio, to develop the primary guidance subsystem for the boost-glider, and more recently was selected by Boeing as subcontractor to produce the flight control electronic subsystem for the space vehicle.

It is significant that the guidance and control challenge will be met with equipment that is almost entirely tried and proven today; in fact, much of it has long been in mass production.

The principal components to be furnished by Honeywell include a 4-gimbal inertial platform, a platform electronics package, a digital coupler and power supply, a malfunction detector, a computer, and the automatic flight control electronics subsystem.

The inertial platform, together with its electronics, digital coupler, and power supply, is the same as that designed by Honeywell for *Centaur*. Its gyros are of a type which has been in production since 1957.

The computer for the inertial guidance subsystem has not yet been announced, but it will be one already in production and currently in use.

The flight control subsystem is basically the adaptive autopilot which Honeywell has spent 7 years developing and flight testing.

• **Initial start in '56**—Honeywell's contribution to the *Dyna-Soar* program may be said to have begun in 1956 when the Bell Aircraft Company (now Bell Aerospace) chose the company as guidance system manager for the "Orbital Glider" program. The selection was followed by five years of design study, much of it company-funded.

During the same period, design and development work was carried out on both guidance and automatic flight control systems of the types needed for other high-performance aircraft and spacecraft. Systems designers gained particularly valuable experience in the course of developing inertial navigation systems for the Army's *AN/USD-5* and *AN/USD-4* high-performance jet drones.

But the development that proved to be of the most direct value to the *Dyna-Soar* program was the inertial guidance equipment developed for Convair for use in the second stage of the NASA *Centaur*.

The direct forerunner of the adaptive flight control subsystem which will be produced for *Dyna-Soar* is the autopilot system which is scheduled to be test flown in North American's No. 3 *X-15* in September of this year.

Funded by a WADD contract for an "Adaptive Flight Test Vehicle for an Advanced Electronic Flight Control," the development and design has progressed into hardware which is now in the qualification and reliability testing phase. Since the *X-15*, like *Dyna-Soar*, must function both as an aircraft and as a spacecraft, many of its design problems are similar; the WADD program has resulted in a solid basis for the development of the *Dyna-Soar* flight control electronic subsystem.

(These adaptive systems are both descendants of Honeywell's MB-5, being produced under an AMC contract for F-101B aircraft.)

Development of the adaptive autopilot system for the *X-15* began nearly seven years ago with Honeywell-financed research directed toward evolving a flight control system which would result in uniformly satisfactory performance, over an extremely wide range of flight conditions, with no dependence upon air data scheduling of system gains.

After the feasibility of the research-developed adaptive system was shown analytically, the Air Force recognized the potential of such a control system, which would automatically accommodate the enormous range of flight conditions to be encountered by more advanced vehicles. It supported pitch-axis feasibility flight tests of the autopilot in an F94C.

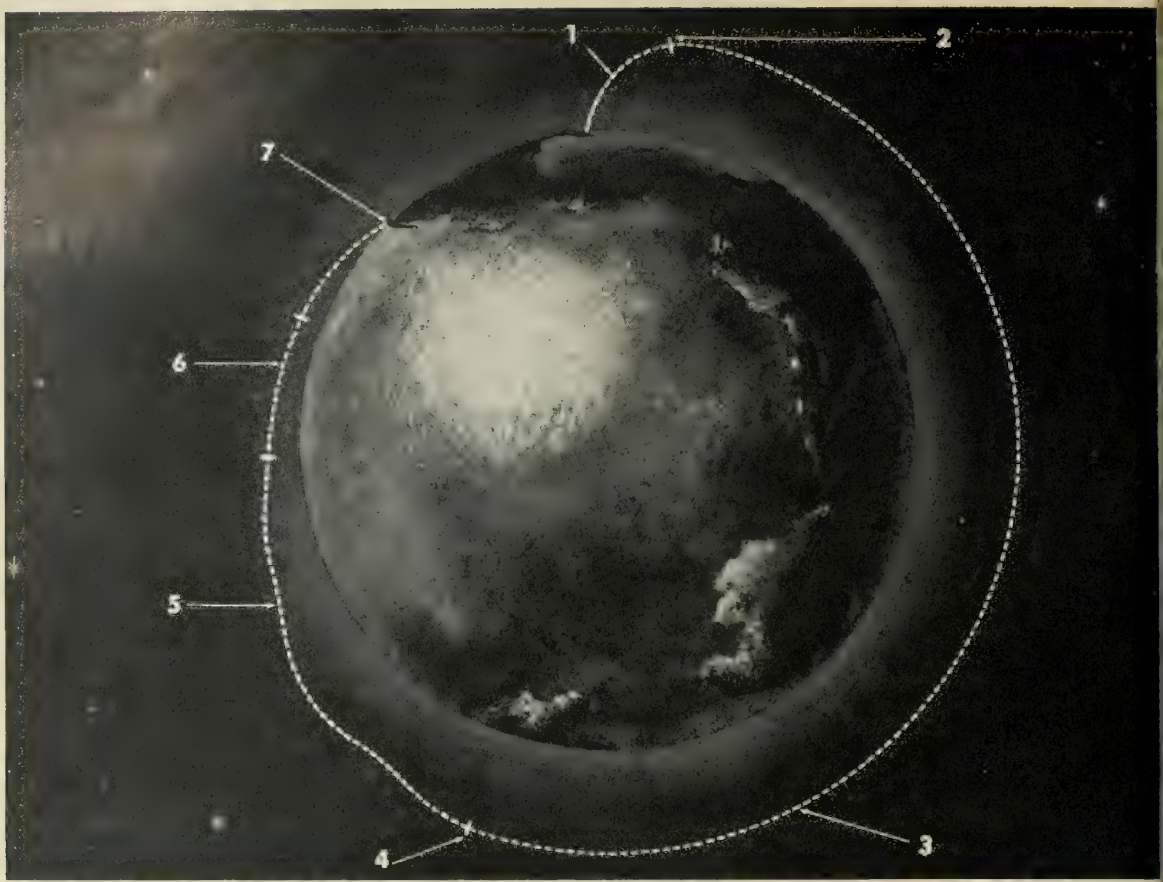
Further work was started on a complete three-axis adaptive autopilot, including outer-loop modes of heading, attitude and altitude-hold and control-stick steering. This autopilot, the M-90, was flight-tested in an F101A in the summer of 1959.

The system included, for the first time, high-frequency magnetic amplifier mechanization which is to be an essential part of the *Dyna-Soar* system. Solid-state switching concepts were employed as extensively as the state-of-the-art would permit.

• **A blend of technologies** — The blending of aerodynamic and reaction

* *Mr. Yingst is program director, Dyna-Soar primary guidance system, Minneapolis-Honeywell, Aeronautical Division—St. Petersburg, Fla.*

*Mr. Seacord is project manager, Dyna-Soar flight control electronic subsystem, Minneapolis-Honeywell, Aeronautical Division—Minneapolis.*




*NON-ORBITAL FLIGHTS WILL FOLLOW this operating sequence in first tests of the Dyna-Soar boost-glider: (1) Launch by Titan II booster from Cape Canaveral; (2) Separation—inertial guidance and flight control systems take over; (3) Guidance and control systems keep the craft in its required flight path; (4) Initiation of re-entry into the atmosphere from space; (5) Re-entry maneuvers within the safe flight corridor; (6) Dissipation of surplus energy and reduction of speed, and (7) Touchdown at Edwards Air Force Base, Calif.*

controls for *Dyna-Soar* poses a particularly interesting problem.

The use of reaction control for vehicle stabilization and maneuvers requires the expenditure of considerably more power than that required to perform the same task through aerodynamic controls, provided the aerodynamic controls are sufficiently effective to perform the task. For this reason, a system for *Dyna-Soar* has been devised that will make maximum use of aerodynamic controls and will use reaction control only when the aerodynamic control effectiveness falls below a set value, and when under normal operation the error signal in any axis exceeds a predetermined amount.

The key element within the adaptive control system is an automatic gain changer working in conjunction with a self-evaluating control loop. The output level of the gain changer is inversely proportional to the aerodynamic control surface effectiveness. When the gain-changer output level exceeds a given value, the reaction control system is switched in; when it drops below a second predetermined level, the reaction control system is switched out.

In simulation studies the optimum switch-in and switch-out levels have been found to be separated by 20% of the total gain-changer output range. This difference is required to prevent oscillation between the two control conditions.

To accommodate the situation in which the error signal exceeds the present value, the system includes an electronic deadband in the switching amplifiers which drive the on-off reaction valves. This arrangement prevents a slight error between the actual and the the desired system performance from activating the reaction controls.

Finally, the system uses integrating servo amplifiers to insure minimum system error and maximum automatic aerodynamic trim, so that the aerodynamic controls have full authority to null any system error signal before the reaction controls are used.

The adaptive system uses 3.5-kc magnetic amplifiers as the basic electronic building blocks in bridge signal amplifiers, operational amplifiers, and various other functions. These magnetic amplifiers are inherently reliable devices and display extremely low drift rates with a null shift of less than 1 microampere of equivalent input current over a temperature range of −55° to +125°C. Compensated amplifiers with matched cores can reduce even this drift by a factor of up to 4.

The frequency response of the 3.5-kc magnetic amplifier is approximately 10 times that of its 400-cycle counterpart and its size about ¼.

Where transistor application is necessary, the solid-state device is operated in its switching mode rather than linear fashion when possible. Significant improvement in reliability has been accomplished with this technique.

• **First test flights**—*Dyna-Soar I* will not be orbital, but it will fly through an extremely wide set of flight conditions, from high supersonic

*(Continued on page 51)*

# Microdot Appoints Avnet for Multi-Pin

LOS ANGELES — An exclusive long term agreement for the distribution of Microdot's new microminiature Multi-Pin connector series has been awarded by Microdot to Avnet Electronics Corporation.

Microdot's Multi-Pin is only one-quarter the size of present "miniature" types and features complete interchangeability of parts. Multi-Pin inserts are available in a variety of straight power, straight coaxial, and combination power-coaxial layouts. Power contacts are interchangeable without changing inserts, allowing hermaphroditic contact arrangements to be set up (a mixture of male and female contacts within the plug or receptacle, allowing hot leads to both plug and receptacle).



**Available in three shell sizes, Microdot's Multi-Pins can contain up to 61 power or 19 coaxial contacts in a 1¼" shell.**

According to Microdot, Avnet will supplement Microdot's sales engineers and seventeen sales representatives with their own sales engineering staff and provide an extremely well organized and broad based national distribution from Avnet's eight stocking locations. The agreement applies to the standard line of cylindrical Multi-Pin connectors, with a separate non-exclusive agreement covering other types and Microdot's coaxial connectors and cable. Present distributors for Microdot will continue to carry the standard line of coaxial connectors and cable on a non-exclusive basis.

Avnet currently has a large initial Multi-Pin stocking order in each of their facilities for immediate delivery. Future orders are expected to be substantial.

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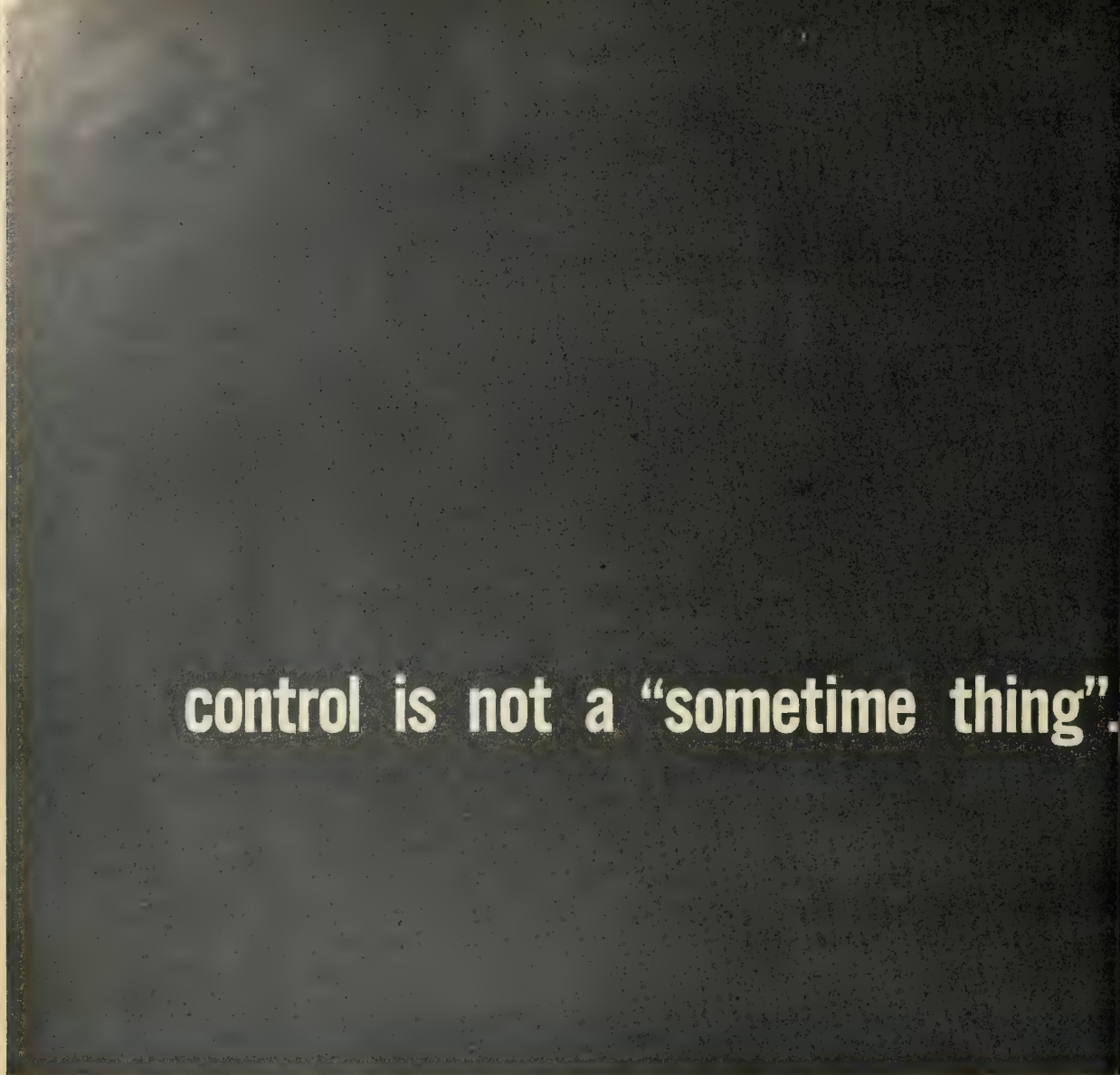


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Everytime is the time for control reliability. A miniscule error in a missile's flight could jeopardize the successful accomplishment of a mission. "Mission Accomplishn depends on all system components functioning properly every time.

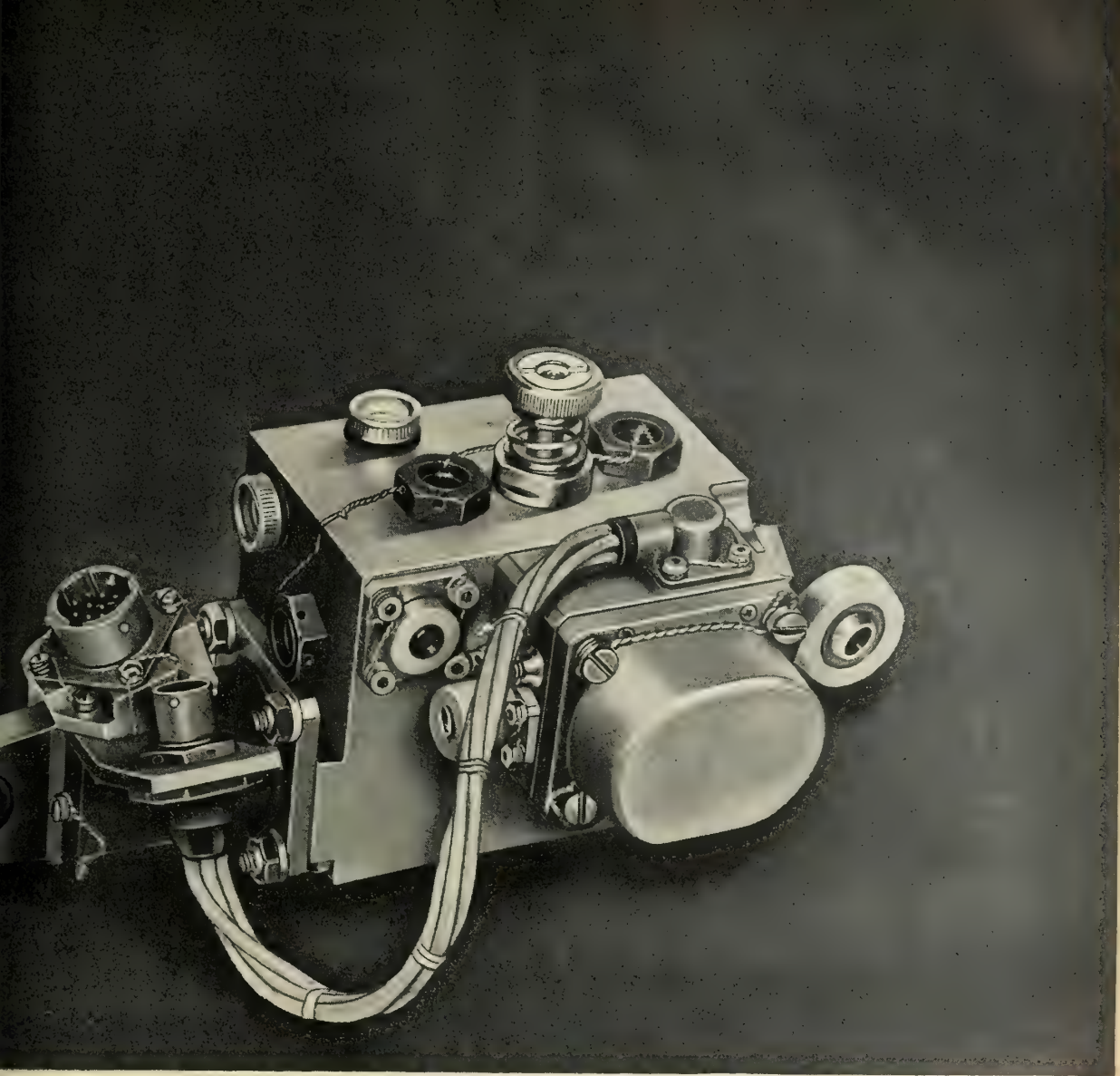
The BS-20 Actuator in the Army's Pershing Missile* was produced under condi which embody micro-machining to tolerances of 50 millionths of an inch . . . elect circuitry which can measure 1 millionth of a second and conversions of an ounce of sure into a force of 8,000 pounds. All are a part of Huyck's world of "positive precis

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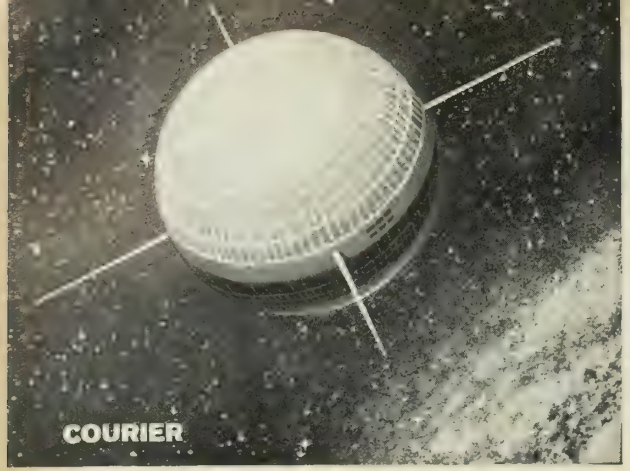
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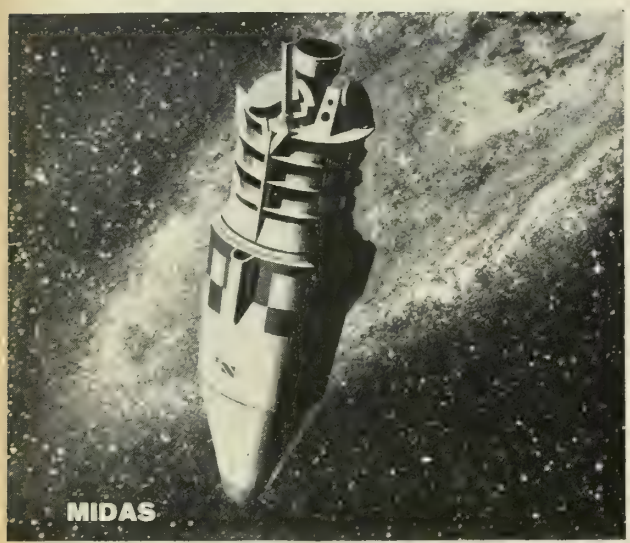
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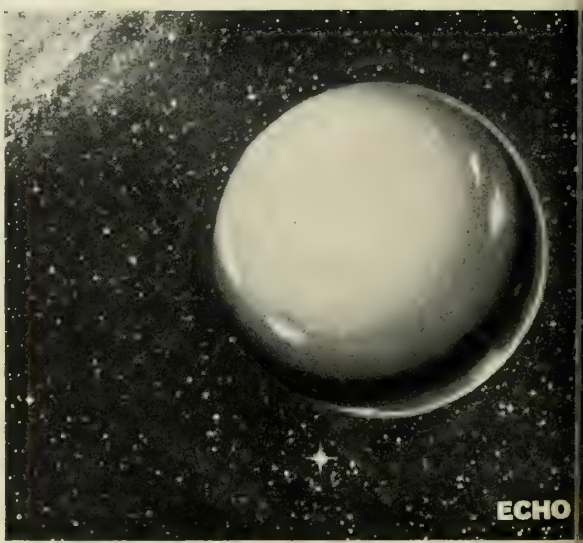
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(Continued from page 46)

speeds at low altitudes where control surface effectiveness is extremely large to altitudes so high that only reaction control is effective in controlling attitude.

Re-entry presents difficult problems in both vehicle protection and pilot safety, as well as equipment environment. The flight control electronic system must control the aircraft within a narrow-flight-condition corridor whose boundaries are set by both structural and temperature limitations.

The necessary limiting of normal load factor and critical temperature will be accomplished by the technique of feedback limiting, drawing heavily from the philosophy used on the MB-5 autopilot for the F101B. Inert gas cooling will be used for the electronic equipment.

• **Guidance reliability paramount**—In studying the *Dyna-Soar* inertial guidance subsystem requirements, Honeywell considered that the specifications called above all for proven hardware which would require a minimum of modification. The selection had to be made from three guidance systems then in production.

The choice fell to the platform developed for the *Centaur* for the following reasons:

–It was based on a gyro (the GG8001) that had been in production since 1957. Over a thousand of these had been made.

–Its platform, with provisions for both gimbal flip and electrical flip, has the most nearly perfect all-altitude capability.

–It includes all the mirrors and the prism required for complete field checkout, test, calibration, and alignment.

The inertial platform is a 4-gimbal assembly using three Honeywell miniature integrating gyros (GG8001B1) and three Honeywell pendulous accelerometers (GG116A2). The gyros and their associated gimbal-drive servo loops serve to keep the first (azimuth) gimbal in a fixed relationship to inertial space, which is the prime reference for the guidance system.

The accelerometer is relatively new, but more than a hundred of them are already in use.

The primary function of the inertial guidance subsystem, during the boost phase, is to guide *Dyna-Soar* onto the correct trajectory for accomplishing its mission. To do this, it senses the acceleration inputs, determines the platform and vehicle attitude, generates the steering commands for transmission to the flight control system, and finally commands the engine cutoff when the programed velocity and attitude conditions are met.

During the sub-orbital flight phase and re-entry, the main function of the inertial guidance subsystem is to provide the computation necessary for guidance and energy management in all phases of flight.

• **Computer selection**—The selection of an airborne digital computer for the inertial navigation subsystem turns mainly upon the following factors: Proven reliability, which together with a good production history is the most important criterion; capacity and speed; compatibility with Honeywell guidance equipment; and adaptability to the problems presented by launch site loading and airborne power interruption.

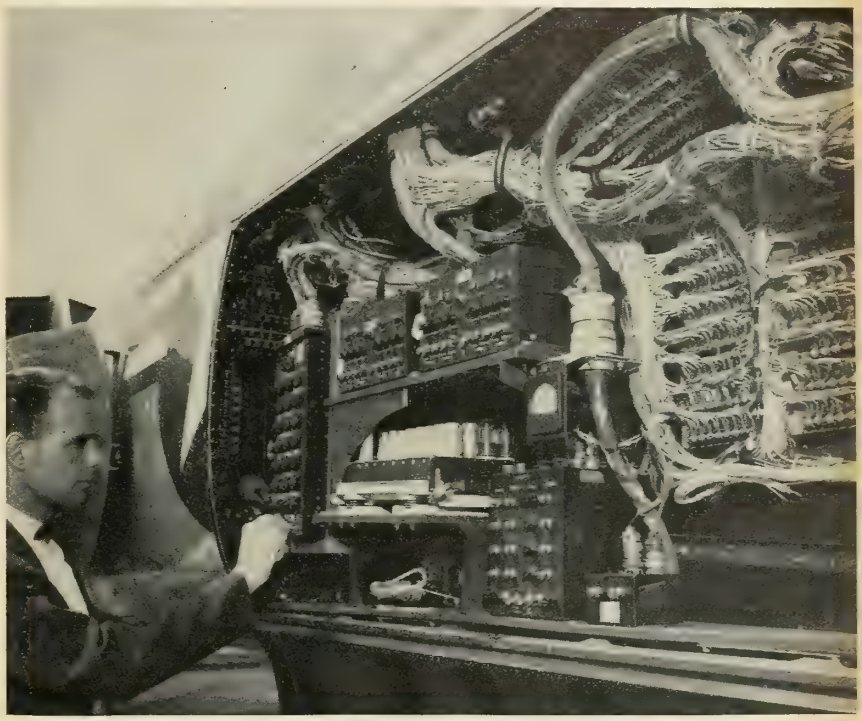
Within the guidance system, the computer will continuously compute and provide as outputs for display a number of quantities that may well exceed 19 or 20. The range of these is from the relatively simple attitude indications to complexes such as the glider's geocentric latitude and longitude.

Extremely high mission reliability is a requirement for *Dyna-Soar*. To achieve very high reliability without compromising fail safety, the Honeywell adaptive system makes use of the compensating features of a self-evaluating loop. This arrangement will compensate for any system gain reduction resulting from an open signal failure in one channel, and it uses relatively simple fault detection and isolation circuits, since only hardover failures require specific disconnection. In this way the conventional multiple redundancy which improves fail safety but reduces reliability is replaced with a dual redundancy arrangement which, in the adaptive loop, increases both.

Since *Dyna-Soar* will be an unpowered glider during most of its flight, its "energy management" will be of crucial importance. Very rapid and accurate correlation must be made continuously between the amounts of kinetic and potential energy remaining, and these energies must be used or dissipated in such a way that the pilot is allowed a maximum of descent and landing maneuverability.

The energy management concept to be employed is one in which the envelope of maximum maneuvering capability of the glider is continuously computed. The result of this computation may be presented as an "energy fan" in which maximum range is achieved by flying at maximum lift-over-drag ratio, and minimum range by flying at the maximum coefficient of lift.

The trajectory that will give the maximum maneuver capability will then maintain the destination point at the center of the energy fan. ⌘



*ADAPTIVE FLIGHT CONTROL system under development by Minneapolis-Honeywell for Dyna-Soar is an outgrowth of, and will be very similar to, that used in Air Force F-101 Voodoo jet interceptor shown above. Essentially an autopilot, the system adapts itself electronically to its environment during flight.*

## Gyros Vary Widely

*(Continued from page 23)*

a two-axis rate gyro with a mercury rotor which is driven by a rotating magnetic field. A rotation about an axis other than the spin axis causes a differential pressure in the spinning mercury along the spin axis. A pressure transducer serves as the output.

In the field of high-accuracy gyros, there is a sharp divergence of opinion on what is the best approach.

The Army Ballistic Missile Agency has committed itself to the position that gas-bearing gyros are the best. This is a reflection of the fact that much of the work done at ABMA is a continuation of the German *V-2* program. The *Redstone, Jupiter,* and *Explorer* satellites all attest to the effectiveness of this approach. These gyros were built first by Ford Instrument and later by Sperry-Farragut Division of Sperry Rand. The new Army *Pershing* missile has a guidance package which utilizes gas-bearing gyros built by Bendix-Eclipse Pioneer Div.

The MIT Instrumentation Lab, under the direction of Dr. Charles S. Draper, is equally committed to the belief that fluid-floated gyros represe the most promising way to obta higher-accuracy gyros. The Air For and Navy have supported Dr. Drape position.

The *Thor, Titan, Atlas, Mace,* ar *Polaris* guidance packages all emplo fluid-floated gyros as the basic re erence.

However, there is no question th each represents a satisfactory solutio Interestingly enough, private compani originally tended to support the po tion of their customers but have no begun designing and building both flui floated and gas-bearing gyros—and at least two cases, a combination both.

A discussion of the relative mer of each approach might well be order. The objective is to reduce to low a level as possible the precessi axis torques. By flotation to zero buo ancy there should in effect be no lo on the bearings.

In the floated gyro, the rotor floated in an outer case. This can be single-degree-of-freedom gyro such designed by MIT, or a two-degree-o freedom gyro as built by Litton Indu tries and American Bosch Arma.

The use of a flotation fluid requir very close temperature control lest t density of the fluid change with te perature and introduce an error. Th temperature-control circuits are indispensable requirement of flu floated gyros.

One of the areas being pursued many firms is devising flotation flui which are less sensitive to temperatu variation.

There are two types of gas bearing hydrostatic and hydrodynamic. Hydr static bearings require an exter source of pressure, usually a small tegrally mounted compressor. Hydr dynamic bearings do not require external pressure source but in eff produce the necessary supporting pr sure by virtue of the relative moti between the journal and bearing.

The hydrostatic gas bearing is us in the same manner as the fluid in floated gyro (to support the rotor) a has the advantage of being less te perature sensitive. However, it is s ceptible to contamination from compressor supply.

The hydrodynamic gas bearing growing in popularity as a pure des and also in hybrid form. Both M neapolis-Honeywell and Kearfott ha developed hybrid floated single-degr of-freedom gyros. These use hyd dynamic bearings on the rotor s axis instead of conventional ball be ings, plus flotation of the rotor sembly in the conventional manner.

The advantage over ball bearings such an arrangement lies in the abse





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of metal-to-metal contact during the operation of the spin-axis gas bearing.

In theory, a gas bearing, both hydrodynamic and hydrostatic, has no life limitation due to wear. However, the limiting factor in a hydrodynamic gas bearing is the number of starts that can be made without ruining the bearing surface.

Where quick warmup or instant readiness is required, running the gyro motor continuously becomes attractive; it is in this application that these gyros will be most useful. They also yield a much cleaner output signal due to absence of bearing noise, with a consequent improvement in drift performance.

The Minneapolis-Honeywell gyro is almost entirely of ceramic construction while the Kearfott gyro limits the use of ceramics to the spin bearing.

The advantage of using ceramics for the bearing surface only is that a higher angular momentum can be obtained in the same size float. A surface hardness in excess of nine on the Moh scale is required for the bearing; while it can be obtained with metal, ceramics offer the additional advantage of freedom from galling.

Ceramic gas bearings have been started hundreds of times with no perceptible wear, even when viewed under a microscope. However, the entire gyro assembly still needs a precise temperature control.

A gyro possessing high-performance capability which uses hydrodynamic bearings and no flotation is being employed in the *Minuteman* guidance package. It was designed and built by Autonetics. This is a two-axis, free-rotor gyro with a spherical hydrodynamic bearing.

In effect, the gyro has three degrees of freedom—unlimited freedom about the spin axis and limited freedom about two orthogonal output axes. Its use in the *Minuteman* provides the desired instant readines by continuous running of the rotor.

A similar gyro is being built by Kearfott for the Navy.

The hydrodynamic gas bearing is not a panacea for all applications. Properly used, it presents a very attractive technical approach for improving gyro performance. In space vehicle applications, however, where long flight duration is required, gas-bearing rotors undoubtedly will be used in the gyroscopes.

Efforts are being made to improve the performance capabilities of proven gyros by adapting some new error compensation techniques. One of these, used by Sperry and others, involves rotation of the gimbal bearings in an effort to average out or accelerate the averaging effect of the random gyro torques.

This technique is effective and can yield a non-floated gyro having a drift rate of better than 0.5 degree/hour with a wheel angular momentum of $8 \times 10^6$ gram-cm$^2$/sec.

Another technique uses case rotation of a two-degree-of-freedom gyro about an axis colinear with the gyro-rotor spin axis, which serves to average out unbalance forces about that axis. This scheme is used by Bell Aerospace in their Hipernas floated gyro and by Kearfott in both a floated and non-floated gyro.

Two other compensatory techniques used to improve gyro performance are feeding back accelerometer signals to compensate for acceleration sensitive gyro errors, and using intentional thermal unbalance to center floated gyros.

The performance of a stable platform can be no better than that of the gyro sensors. However, the inherent performance capabilities of a gyro may be compromised by an improper gimbal structure. Therefore, some investigators, attracted by the opportunity to get rid of the gimbals, have produced gimballess platforms.

There are two approaches. One scheme is predicted on the two-concentric-spheres arrangement. The inner sphere contains all the sensors and is




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suspended relative to the outer sphere but possesses angular freedom of move ment.

The main difficulty with such a arrangement is not so much in the sus pension as it is in the means of trans ferring power and data between th inner and outer spheres. It seems un likely that such a scheme will be ap plied to operational hardware in th near future.

A more attractive scheme—on which is being actively pursued—i known as the body-mounted or gim balless system, mentioned earlier. Here the gyro sensors are rigidly mounte to the airframe and the output signal are fed to a computer which simulate by computation the functions of th gimbal.

The most effective implementatio of such a scheme demands that th computer be digital in nature. Fo compatibility, the output signals fro the gyros, and from the accelero meters as well, should also be digit in nature.

Existing gyros can be used in digit modes of operation with only sligh modification in their precession ax components (torquer and takeoff). Fo example, pulse torquing is a method which the torquer signals provided the gyro are in the form of discre pulses of energy rather than a co tinuous analog current. Since it is a amount of energy which is introduce summing the number of torque puls is equivalent to integrating a sustaine current. Since the torquer scale facto is known, direct digital exchange of i formation between the computer an gyro becomes possible.

The present difficulties of such scheme are threefold. First is the pro lem of devising the necessary electroni to generate a train of pulses with th assurance that each pulse contai exactly the same amount of energ Second, the gyro must be designed that its transient response is compa ible with the input pulse, and the gy torquer must be designed so as not overly distort the input. The third ar of difficulty is obtaining basic senso with dynamic ranges sufficiently wi to utilize the computer's capability.

Body-mounted gyros require great angular freedom of movement abo their precession axis than comparab conventional gyros. Wide-angle, flui floated gyroscopes are now being bu by Minneapolis-Honeywell, Kearfo and Nortronics.

The Air Force is funding develo ment of the AJN-7 system by the Fo Instrument Company; this is a fea bility model of a gimballess platfor Several other firms, including thc mentioned above, are following th approach with their own funds. Its u



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# Rate Gyroscopes

## General Performance Specifications

### SUBMINIATURE

**GENERAL**

**Maximum Angular Rate**
0.1 rad/sec to 10 rad/sec

**Undamped Natural Frequency**
15 cps to 80 cps
(Actual measurements)

**Threshold and Resolution**
0.03% of maximum rate

**Friction and Hysteresis at Null**
Less than 0.10% of maximum rate

**Linearity**
½% of maximum rate plus ¼% of reading rate

**Damping Ratio**
0.2 to 2.0 critical (room temperature)
Variation (between-55°C and 80°C) is 0.4 total
(Frequency response measurements)

**AMBIENT CONDITIONS**

**Temperature**
-55°C to 80°C (Standard)
(Up to 150°C on request)

**Vibration**
50 G up to 2000 cps

**Shock**
100 G along any axis

**MOTOR**

**Excitation**
26 V ± 10%, 400 cps, 3—phase
26 V ± 10%, 400 cps, 2—phase

**TRANSDUCER**

**Signal-To-Noise Ratio**
1,000:1 (Minimum)
(Based on maximum rate)

**Zero Calibration**
0.01 to 0.2% of maximum rate
(Depending on overall requirements)



**SIZE: 15/16" DIA. x 2-1/2"**

### MINIATURE

**GENERAL**

**Maximum Angular Rate**
0.05 rad/sec to 10 rad/sec

**Undamped Natural Frequency**
8 cps to 80 cps
(Actual measurements)

**Threshold and Resolution**
0.03% of maximum rate

**Friction and Hysteresis at Null**
Less than 0.20% of maximum rate

**Linearity**
½% of maximum rate plus ¼% of reading rate

**Damping Ratio**
0.2 to 2.0 critical (room temperature)
Variation (between-55°C and 80°C) is 0.4 total
(Frequency response measurements)

**AMBIENT CONDITIONS**

**Temperature**
-55°C to 80°C (Standard)
(Up to 150°C on request)

**Vibration** 20 G up to 2000 cps

**Shock** 100 G along any axis

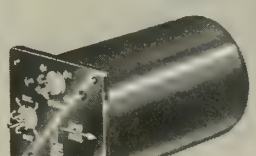
**MOTOR**

**Excitation**
115 V ± 10%, 400 cps, 3—, 2—phase
26 V ± 10%, 400 cps, 3—, 2—phase

**TRANSDUCER**

**Signal-To-Noise Ratio**
1,000:1 (Minimum)
(Based on maximum rate)

**Zero Calibration**
0.01 to 0.2% of maximum rate
(Depending on overall requirements)



**SIZE: 1¾" DIA. x 3⅞"**

### D. C.

**GENERAL**

**Maximum Angular Rate**
6°/sec minimum

**Undamped Natural Frequency**
2.5 cps at maximum rate

**Threshold and Resolution**
0.5% of maximum rate

**Friction and Hysteresis at Null**
Less than 1% of maximum rate

**Linearity**
5% of maximum rate

**Damping Ratio — Air Damped**
1.0 to 4.0 critical (room temperature)

**Output at Maximum Rate**
4 ma with 500 ohm load
(Optional output potentiometer available)

**AMBIENT CONDITIONS**

**Life**
1500 hours minimum

**Temperature**
-65°F to 165°F

**Vibrations**
5 G up to 2000 cps

**Shock**
25 G along any axis

**MOTOR**

**Excitation**
28 VDC (Standard)
14 VDC (On request)



**SIZE: 2.271" DIA. x 4.667"**

### SUBMINIATURE INVERTER-DEMODULATOR

**GENERAL**

**Maximum Angular Rate**
0.1 rad/sec to 10 rad/sec

**Undamped Natural Frequency**
15 cps to 80 cps

**Threshold and Resolution**
0.03% of maximum rate

**Friction and Hysteresis at Null**
Less than 0.10% of maximum rate

**Linearity**
½% of maximum rate plus ¼% of reading rate

**Damping Ratio**
0.2 to 2.0 critical (room temperature) Variation (between -55° and 80°C) is 0.4 total (Frequency response measurements)

**AMBIENT CONDITIONS**

**Temperature**
-55°C to 80°C

**Vibration**
50 G up to 2000 cps

**Shock**
100 G along any axis

**MOTOR**

**Excitation**
28 ± 3 VDC (internally inverted to drive a hysteresis motor)

**TRANSDUCER**

**Signal-To-Noise Ratio**
1,000:1 (Minimum)
(Based on maximum rate)

**Zero Calibration**
0.2% of maximum rate or less (Depending on overall requirements)




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in future years appears very probable.

The basic limiting threshold for a high-accuracy gyro depends on the residual torques caused by the suspension. To many investigators, improving the suspension appears to be the way to improve gyros.

The University of Illinois, General Electric, and Minneapolis-Honeywell are developing gyros which use electrostatic forces to suspend the rotor. Other firms have dropped their endeavors in this field.

A basic problem, in addition to the high voltages and low vacuum usually required, is the difficulty of obtaining the high accuracy, close tolerance, and homogeneous elements required for the rotor and suspension system.

The Air Force is seeking means to obtain spheres with tolerances beyond the current state of the art.

General Electric and Kearfott are both developing cryogenic gyros. This type is in essence a device using a magnetic suspension in which the performance of the magnetic circuitry is dependent upon superconductivity phenomena. Both electrostatic and cryogenic gyros are still predicted on the use of the spinning rotor.

In an attempt to eliminate the problems inherent in a spinning rotor, efforts are being made to develop gyroscopic devices which depend on the gyroscopic properties of molecules and atoms. Most of these schemes are foundering for lack of a practical scheme of detecting the output signal. In many cases, the associated electronic detection circuitry is so complex as to negate the simplicity of the basic sensor.

At present it does not appear that molecular gyros will become operational within this decade.

One thing should be clear from the preceding comments: the field of gyroscopes is anything but static. There is a great deal of ferment in ideas and great deal of competition between firms. There may even be some doubt as to whether the market is able to support so many competitors. However, any elimination is most likely to be on the basis of inability to develop new ideas.

There is always a market for a better gyro. ⁂

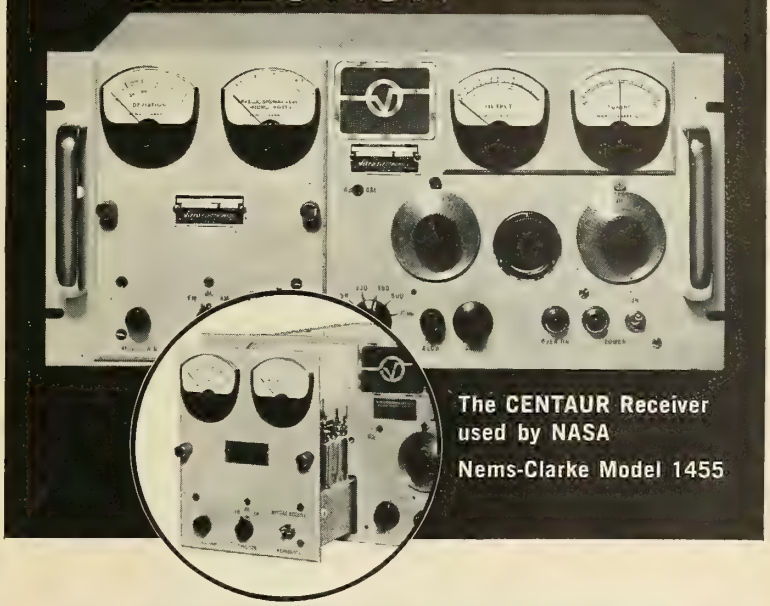
## Market Outlook

*(Continued from page 20)*

drift errors; better understanding of physical properties of materials for achieving improved performance in varied environments; lack of long-term stability in many critical materials experienced during transport or extended storage.

–Electronic hardware. Connectors and intermodule connections are still


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Available as an accessory unit is the Nems-Clarke IFC 1400 Pre-Detection Converter which permits use of the 1455 with stationary-head instrumentation tape recorders for pre-detection recording.

See the 1455 Receiver at the I.R.E. Show, Booths 3917-3919.

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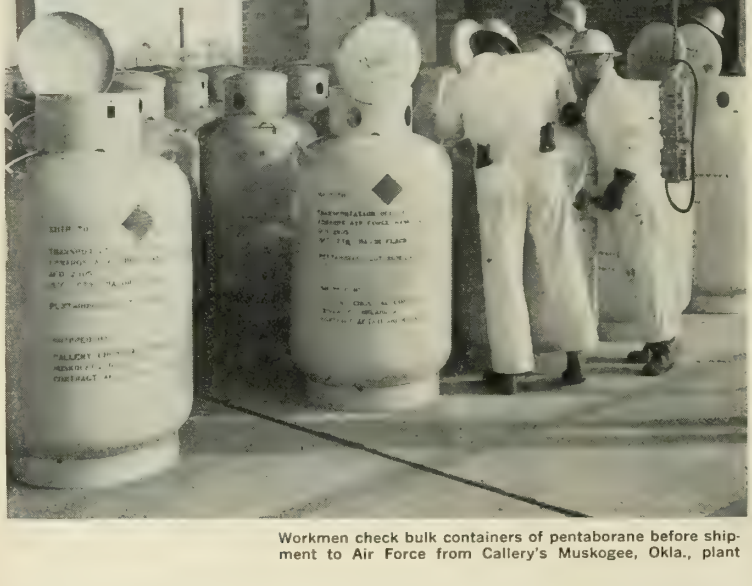
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Pentaborane, like most of the other highly reactive chemicals in propulsion systems, takes respectful handling by properly supervised and trained workers. The recent start-up of tonnage production and shipment of pentaborane under Callery's Air Force contract is one indication of how well handling details have been worked out.

Another sign of pentaborane's coming of age is the issuance of safety and handling data sheets for the product by Manufacturing Chemists' Association and National Safety Council.

Callery has been able to bring the tremendous potential of the boranes to the propulsion foreground through the use of sound design and construction principles and thorough training of workers in safe handling techniques.

Write Callery for specific details on how your facility can investigate the new levels of energy available through the boranes. As the originators of boron fuels — from test tube to tonnage production — we can guide you in their chemistry, behavior and proper handling.

---

CALLERY CHEMICAL COMPANY, CALLERY, PA.
Please send data sheets and handling instructions on Pentaborane.

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being blamed as the most unreliabl single class of components; need smal sensitive target trackers (optical, IR radar) for objects of very small cross sectional area; components advances i general lag system advances by a con siderable margin—need more produc improvement money as well as researc funds; better methods for cooling an more R&D for cooling of solid stat systems.

–Systems. Better control of aero dynamically unstable missile frames a they pass through jet stream (problem here is presence of liquid-sloshing an body-bending resonances at frequencie near the control frequencies); contro problems due to aerodynamic and tran ducer crosstalk in aerodynamically con trolled missiles; sealing and pressuriza tion techniques need considerable im provement.

What will be the solution to all thes problems—besides hard work? A Boe ing spokesman feels there is one glarin answer to the reliability problem i complex G & C systems. Simplificatio of equipment, he said, is the most ob vious and effective approach, but en gineers must be willing to accept som sacrifice in performance.

An Autonetics official may hav come closer to the heart of it all whe he said: "It is true that we have majo technical problems to overcome, bu one area consistantly overlooked is th 'people' problem associated with th development of complex electro mechanical equipment. The custome and the contractor must learn to resi oversophistication and to reduce sy tems to an absolute minimum. This wi result in optimum mechanization fo specific operational requirements."

## *Mini-Weld Technique*

*(Continued from page 2*

matrix wire to a component lead stic ing through a similar hole in the Myla The films are coded to show the we points, component leads and matr wire materials.

Matrix wiring is used rather th the more common point-to-point nick ribbon connections for several reaso First, the matrix is a testable sub sembly, somewhat similar to an etch circuit board, since the circuit is weld together on the Mylar film and or needs the correct placement of t components to complete the assemb Secondly, the large number of cro overs provides ease of engineering la out and often makes it possible to l out complicated wiring patterns in o matrix rather than in two or thr point-to-point layers. This is desirab because all the matrix and compone

elds are accessible during final test nd are not covered by a layer of in- ılating Mylar.

A third advantage of the matrix echnique is the ease with which de- gn constraints may be established to peed the layout process. A fourth ad- antage is the ease with which differ- nt materials may be used within one ssembly to insure the compatibility f materials to be welded.

After final testing of a finished ircuit, the entire unit is encapsulated, sing precision molds, in a fire-resistant, lass-filled epoxy casting resin. The en- apsulant provides a protective sur- ounding for the electronic circuits, nd creates a reinforced structural lock to withstand the rigors of military nvironments.

• **Wiring modules**—The wiring ıodule, used to interconnect the cir- uit units, is a condensed version of ıe conventional back-panel wiring or ıbling harness used with every elec- onic system.

The same basic matrix scheme used the circuit modules is the basis of ıe wiring module matrix. In this case, l the electrical connections are made etween pins in the wiring module, ther than between components and ıtput pins. Due to the large number pins involved, which may be as high 3600, multiple layers of matrices ust be used. As many as 25 layers ıve been used to interconnect all the ns in the *Polaris* wiring module.

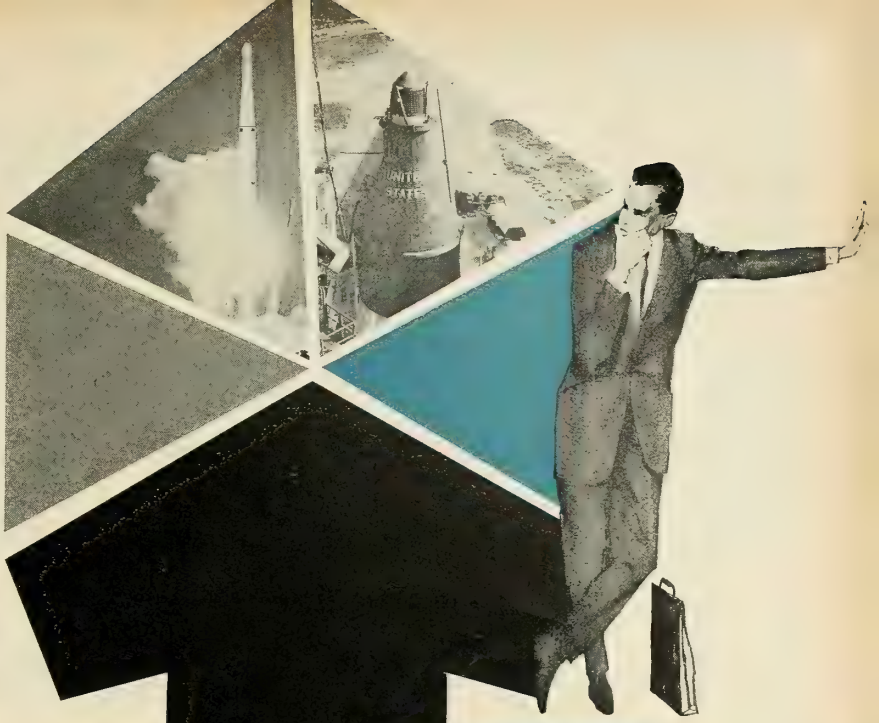
The wiring module matrices are the ily units custom-built for each sys- m. Each is tailored to accommodate fferent locations for various types of rcuit modules and the difference in ımber and types of modules. The out- le physical appearance of all wiring odules is the same, differing only in e number of circuit modules that ey will interconnect.

The ribbon matrix method of back- nel wiring is the core of the wiring odule. Several of these matrix layers cked one above the other contain the intermodule signal and power nnections required by the system.

A wiring module matrix is com- sed of a photosensitive film ually 0.004-in. Mylar or cronaflex) printed with lines that the signal ıductors will overlay and other in- mation necessary for its fabrication. e conductors on either side of the ı are welded to each other as re- red through holes pre-punched in film.

The films are exactly reproduced m original drawings upon which the ic interconnections were laid out. ctically all of the information neces- y for the fabrication of the matrix hen reproduced on the film. Mylar cronaflex is used for its excellent

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new career opportunities for engineers and physicists

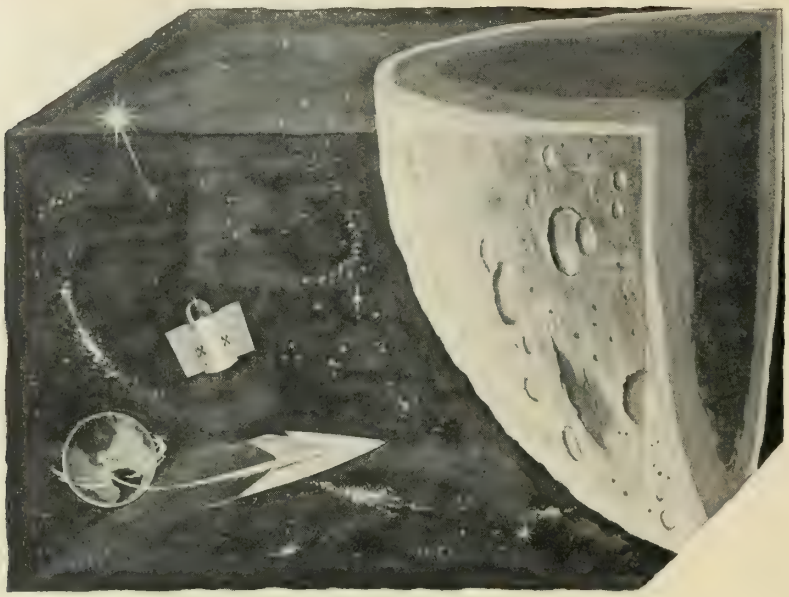
Guided Missiles Range Division of Pan American World Airways has prime responsibility for operation and maintenance of the 10,000-mile Atlantic Missile Range extending from Cape Canaveral into the Indian Ocean. Guided Missiles Range Division's dynamic growth has created new opportunities for Electronic Engineers, Systems Engineers and Physicists with degrees and experience in several fields. If you are qualified and desire to play an intimate, vital role in the nation's major missile test and astronautical explorations, we invite you to inquire about these career opportunities. You will discover that the Florida way of life offers you and your family modern living in an unparalleled vacation setting of sunshine and seashores; and that association with Guided Missiles Range Division offers beyond normal employee benefits, a 90% world-wide air-travel discount. Please address your resume in confidence to: Dr. Gilbert S. Blevins, Dept. B-37 Guided Missiles Range Division, Pan American World Airways, Inc., Patrick Air Force Base, Florida.

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In our continuing drive to improve the art of Space Technology long range objectives, plus definite determinations of values and priorities in terms of national and world-wide aims, are giving added impetus to the work of the Space Sciences Staff at Grumman.

The problems are many, as each experiment in space is characterized by a high degree of attention to individual design and assembly . . . seldom, if ever, would any two probes be identical. The possibility of technological surprise must also be considered in view of the limited knowledge of space as a medium of transit.

The NASA selection of Grumman as Systems Manag to develop the Orbiting Astronomical Observatory Sa lite, serves to illustrate our "in house" capability systems analysis and design of various satellites a space systems.

The Orbiting Astronomical Observatory Satellite a other advance space projects now under study by Space Sciences Staff have created immediate openi for engineers and scientists with the following experien

**Astronomer.** Senior position is available to those interested in the problems of astronomical investigations with the use of orbiting laboratories and lunar exploratory vehicles. Minimum requirements are an advanced degree and several years of pertinent experience.

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**Digital Circuits Engineer.** Experie in logical design and transistor pulse cir design for work on complex digital data tems. BSEE or BS in Physics with a minim of 3 years' applicable experience is requi

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## GRUMMAN AIRCRAFT ENGINEERING CORPORATIO

**Bethpage, Long Island, N**

insulating qualities, high tensile strength, extreme resistance to tearing and, above all, its dimensional stability even at extreme temperatures. The conductors are usually nickel ribbon, nickel wire, nickel-clad copper, or combinations of these.

Between matrix layers is a blank film which insulates one wiring layer from another.

The module is encapsulated with a flame-resistant epoxy resin under a high vacuum to eliminate the possibility of air bubbles which might impair reliability.

The encapsulated wiring module has rows and columns of symetrically spaced rectangular holes. Three of every four holes are identical and have wire-wrap terminals along one edge. Internally, the terminals are welded to matrices and signal or power circuits. Externally, the terminals eventually are wire-wrapped to circuit module terminal pins that protrude through the holes in the wiring module.

• **Wire-wrapping**—To add to the reliability of the MiniWeld system, conventional connectors—a major source of trouble in modular electronic systems—are eliminated by the use of wire-wrap connections.

The split wire-wrap terminal was developed to meet the need for a connection method possessing high reliability and allowing 25 to 50 disconnections within the life of the unit. This terminal is a variation of the original Bell Telephone Laboratories' wire-wrap terminal.

Since the split terminal uses the wrapping wire only as a means of binding the two half terminals together, the main objection to the original technique is eliminated, since the solid copper wire is cut off and does not lead to another terminal. Therefore, the problem of fatigue and breakage of the solid wire is not a problem.

These terminals have recently passed tests of 8 g's of vibration in working assemblies and 30 g's of vibration in dummy units with no detectable difficulties. The dummy units were also subjected to 100 g shock in three axes without any physical damage. The working units have been subjected to a full range of the standard environmental tests as well—including humidity, high and low temperature—after one wrap and after 20 rewraps on each terminal.

Both semiautomatic and manual tools for making the wire wrap connections and a special unwrapping tool are available commercially. In an emergency, field repairs can be made without any tools by hand-wrapping the terminals with a piece of copper wire and soldering in place. The terminals can also be welded together if desired.

This technique gives a gas-tight connection, with high inherent reliability, stemming from the fact that the soft copper wire is physically deformed, when wrapped around the sharp corners of the hard, gold-plated terminals. Multiple conductive paths are also created between the two half-terminals.

The use of wire-wrap terminals has two other unique features. Every terminal of the system is accessible for probing and testing. Also, by unwrapping one element and inserting an insulating material between the terminals, a circuit connection can be isolated from the system for testing or probing without physical removal of the circuit module.

• **Interframe cabling**—Connections between frames and to input-output and power cables is provided by Mini-Cable modules. As many of these modules as are required by the system are connected into the wiring module. The cable modules are wire-wrapped into the wiring module in the same manner as other circuit modules. The wiring module matrices then perform the function of bringing the cable connections to the correct circuit module.

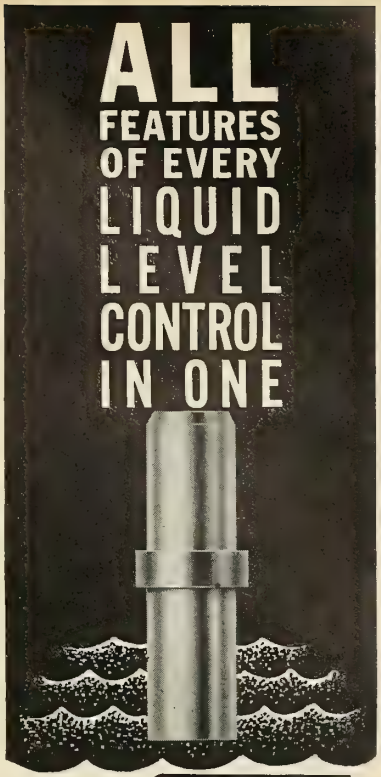
For inter-frame cabling, two dummy circuit modules are used with one at each end of the cable and each wire-wrapped in a different wiring module. The cable used is a flat flexible encapsulated-copper ribbon cable, such as Flexprint.

• **Mechanical assembly**—In a Mini-Weld system package, the circuit and wiring modules are used as the prime structure; their inherent compressive strength is one of the leading design factors.

The basic erector-set structure consists of only one piece of aluminum, a web 0.190 in. thick, about which the circuit modules are clamped. Holes in the circuit modules allow insertion of a clamping bolt. A total assembly consists of five elements on each side of the web, with clamping pads at their extremities.

The clamping bolt, with special hardware, is inserted and then loaded to a value of approximately 400 lbs. This load is transmitted from the clamping pads into the circuit modules and results in a homogeneous post-loaded beam, the main support point being the web in the middle of the circuit module stack. The clamping pad design prevents any air leakage or rattling and allows the circuit module beams to expand and contract axially.

The bulk of the load is delivered to an intermediate web, which transmits the load to a fitting. The fitting, in turn, delivers the load from the intermediate web to the vehicle. To transmit the load from the center and intermediate webs to this fitting,

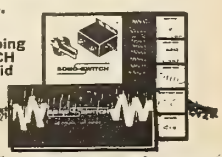




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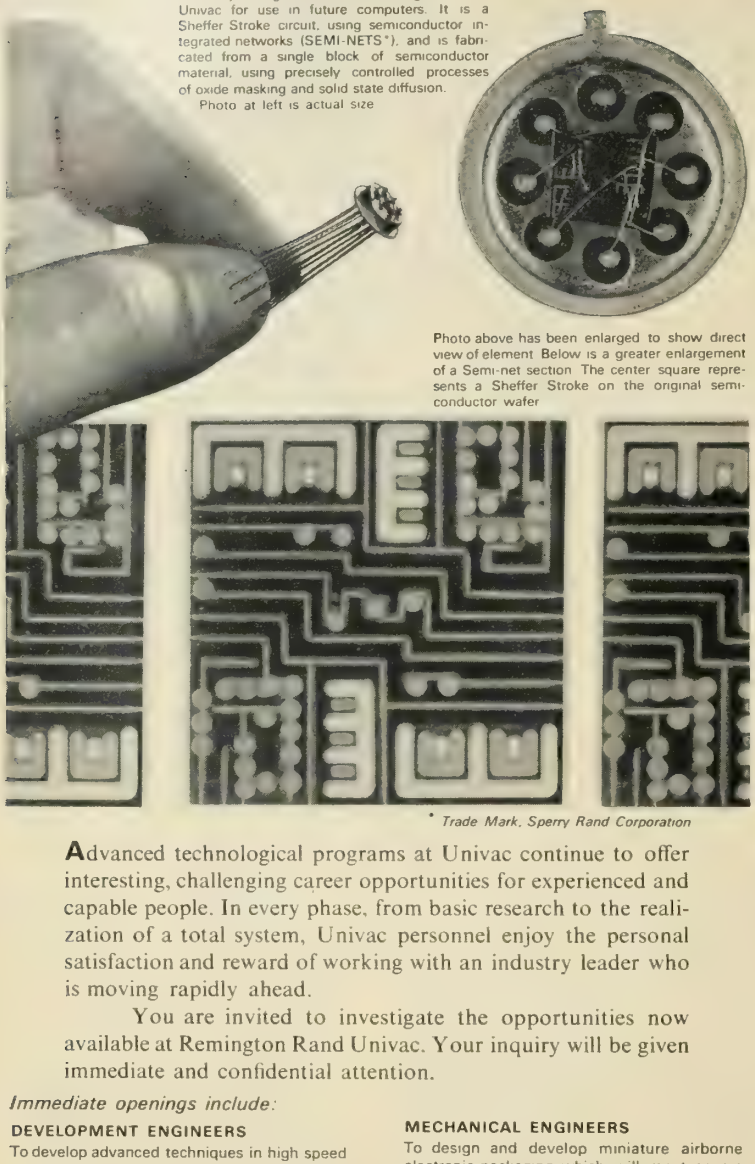
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Developed by the Sperry Semiconductor Division Norwalk, Connecticut, this logical element is currently being utilized at Remington Rand Univac for use in future computers. It is a Sheffer Stroke circuit, using semiconductor integrated networks (SEMI-NETS*), and is fabricated from a single block of semiconductor material, using precisely controlled processes of oxide masking and solid state diffusion.

Photo at left is actual size

Photo above has been enlarged to show direct view of element. Below is a greater enlargement of a Semi-net section. The center square represents a Sheffer Stroke on the original semiconductor wafer

* *Trade Mark, Sperry Rand Corporation*

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modular extruded sections are place between each of the webs. Compre sion bolts are also passed through th extruded side frames of the syste much as the bolt is passed through th circuit module beams. The side fram assembly, therefore, becomes anoth postloaded structure.

The wiring module is placed on to of the webs and fastened with screw The screws hold the module main for assembly purposes, because th many wire-wrap terminals to the circu module beams hold it with an eve distribution of tension.

Postloading the circuit modu beams accomplishes another purpo by clamping the heat exchangers firm between each module. The high cor pressive force between modules kee to a minimum the thermal losses du to the interface between the circu module and the heat exchanger.

Modularity of the machine is o tained by adding extruded side-fram pieces until the desired length is o tained, or by varying the length the various webs in increments of ci cuit module width until the desir width of the machine is designed. B cause of environmental consideratio and limitations in fabricating the wi ing module, the maximum size of a one frame machine has been set at 2( circuit modules.

In stacking the machines one top of the other, each frame is cor pletely independent of the next, sin the total loads are ultimately tran ferred to four hold-down bolts. Th only variable, therefore, is the size the hold-down bolts, which is a fun tion of the number of frames and t size of each frame.

• **Cooling**—The MiniWeld syste is designed to meet the most rigoro thermal environments attainable wi germanium transistors. Large syste may be assembled with forced conve tion cooling that will maintain ma mum transistor case temperatures wit in 8°C of ambient. Forced air may supplied by a self-contained fan sembly in the base of the system pac age or by the vehicle supply. Free co vection may be used in ground-bas systems. Forced liquid cooling m also be used in special applications.

Heat from the surface of the c cuit modules is conducted to the fi heat sink or heat exchanger by mea of aluminum foils clamped betwe the modules by the bolt that ho groups of modules together. The foils carry the heat to cold plates cated between rows of circuit modu if a forced air or liquid cooling tec nique is used.

When a heat sink is used, the fo may be tied to conductive plates th are in turn clamped to the heat sink

# INERTIAL ENGINEERING INGENUITY

Litton's LN-3 Inertial Navigation System for the NATO F-104, now in production, owes its excellent performance to Litton-designed technical features such as:

Integrators with linearity of better than 1 part in 10,000.

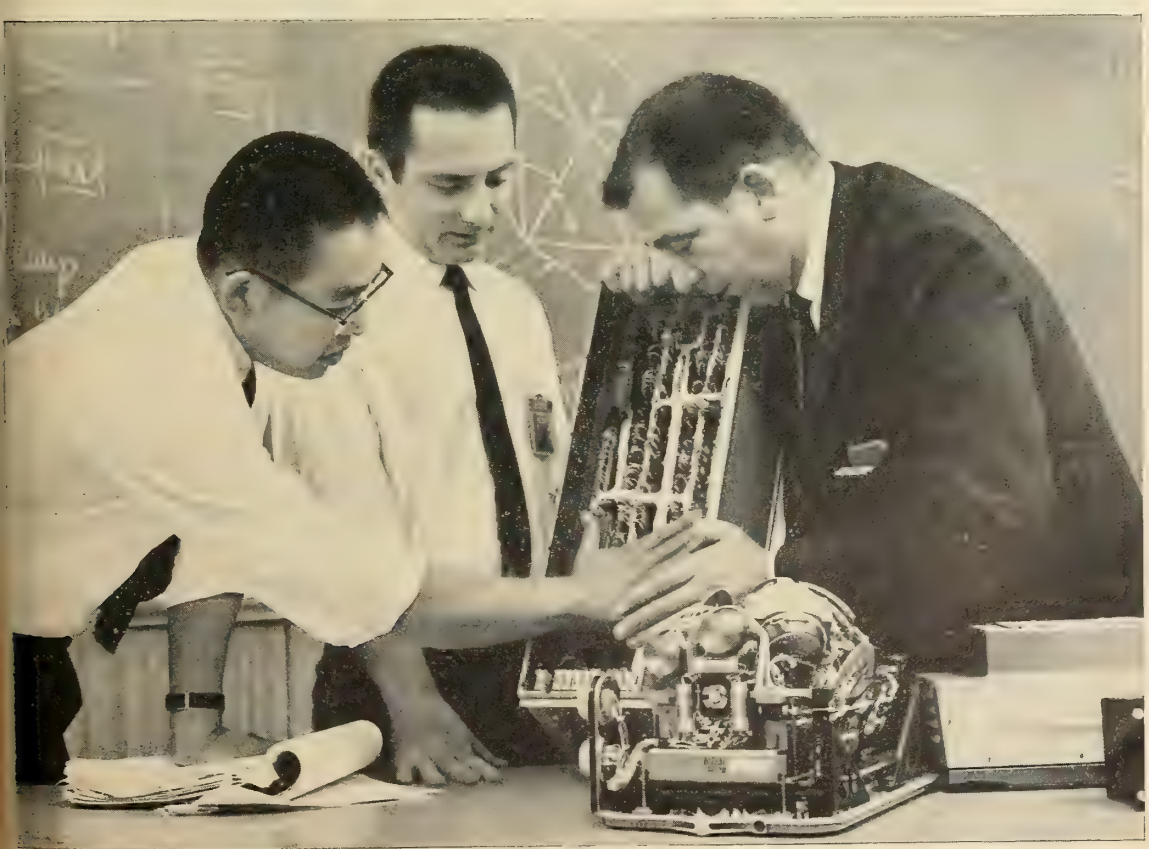
Fully transistorized d.c. amplifiers with internal gain better than $10^7$ with offsets, referred to the input, of 20 microvolts maximum. Operational characteristics are constant between —55°C. and 85°C.

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**GUIDANCE & CONTROL SYSTEMS DIVISION**
**Beverly Hills, California**

John Tamura and Robert Ebner discuss the optimization of the LN-3 Computer Integrator design with Dr. Harold Bell, assistant director of the Guidance Systems Laboratory









# "Delivery room" for a guidance system

Guidance systems and components for some of this country's most advanced ballistic missiles are being born in this room—and no hospital delivery room was ever kept freer from dust and dirt.

It's the "ultra-clean room" at Sperry Farragut—the cleanest of more than 5000 square feet of temperature-controlled clean-room facilities here. Its air locks and dust filters remove from the air all particles larger than 0.3 micron (12 millionths of an inch) and would stop cold the 3-5 micron bacteria dreaded in hospitals. Final assembly of guidance units for the MERCURY and SATURN missiles is carried out here—as well as assembly of a variety of other complex, precision mechanical and electro-mechanical equipment.

This clean room, probably the most advanced in the country in design and construction, is just one example of the ultra-modern facilities for precision military production at Sperry Farragut's 175,000 square-foot Bristol, Tennessee plant. These facilities are manned by a staff with outstanding technical competence and backed by the virtually unlimited capabilities of the Sperry Rand organization.

Our liaison engineers will welcome an opportunity to discuss application of Sperry Farragut facilities and capabilities to your requirements. 0.2

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## Command Guidance

(Continued from page 28)

any momentary loss of signals or other interruptions, the range error can be corrected easily. A technique has been developed to periodically recalibrate range, using the second signal link between ground and missile.

By means of the controls placed upon the two signals, both in the air and on the ground, the reception of only one of the signals would enable the ground to reproduce exactly the second received signal. This reproduction technique allows the range scheme to handle the case of a moving missile.

With a system such as this, we can expect that the missile trajectory will be measured to within 6 inches in range, 3 microradians in angular position, 0.02 feet per second in velocity, and 20 millimicroradians per second in angular velocity. A virtue of this measurement system is that it is independent of absolute range, since these measurement accuracies are constant for any mission. With such accuracies guidance-system errors become insignificant.

• **Hardening possibilities**—At this point, the accuracy of delivery of a payload to target becomes a function of the known position of the target and the aberrations in the re-entry path of the nose cone of the missile. Since this system is not dependent upon the super-precise positioning of a large tracking antenna, it becomes relatively easy to harden the entire guidance site.

Not long ago there was much talk of the thermonuclear warhead being the "final" weapon and leaving "total destruction in its wake." We now know this to be false, and it is possible, with current techniques to build hardened ground sites that will withstand the ravages of a 10-megaton burst a very short distance away.

Launch and guidance complexes can hand over control to an undamaged site if a ground system should be knocked out. Additionally, by staggering launch times, it is possible for one site to control several missiles in flight at once. Thus it is possible to build guidance and launch complexes that can take even direct hits and continue to perform their missions.

Because the guidance computer remains on the ground, it can be made versatile and flexible. This allows storage of almost immediately available data on a large number of targets. Thus any missile can be fired at any target at essentially any time. (Range limitations, of course, must be considered.)

In addition, the ground-based equipment, including the computer, will be greatly simplified. The point has been reached already where only one guidance control officer actually takes part in a countdown.

• **As for jamming**—In the past, the great hue and cry about radio guidance systems has been that of alleged vulnerability to jamming. This argument is not valid, however, since with secure transmission techniques the guidance system can have "orders of magnitude" more effective power than the best and "most intelligent" jammers.

The task of jamming the system is immense considering the effective power advantage, plus the following reaction time requirements:

(1) Discover a missile is being guided

(2) Determine the frequencies being used

(3) Unravel the encoding scheme used

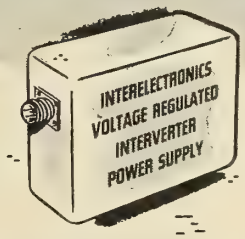
(4) Determine in which direction the missile antenna is "looking"

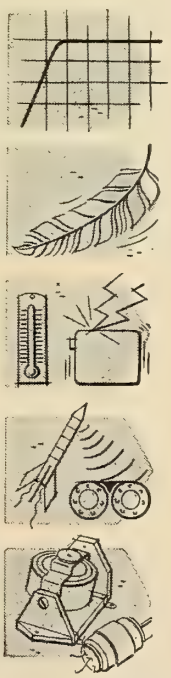
(5) Move about to get within the beam of the missile antenna

(6) Get on the air, on frequency before it is too late

While jamming of any radio link can never be completely ignored, it certainly is not a task for a lonely spy


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Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

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AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

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- **A more complete description of the Laboratory's work will be sent to you upon request.**

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Massachusetts Institute of Technology
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**LEXINGTON 73, MASSACHUSETTS**

with his handy-dandy suitcase jamm
In fact, it is conceivable that it wou
take more and larger equipment th
the ground station itself, emplaced ne
the ground site. Military security pe
ple might have something to say abo
this.

• **Command link**—As has alread
been pointed out, a launch complex c
have considerable flexibility in missi
control, and while salvo, or firing
at once, is a very difficult problem,
can be closely approached.

It is possible to stagger the firi
of a group of missiles and to contr
during the critical periods of flight. T
firing rate is based, among other factor
on the precision of control during t
non-radio period of guidance.

Thus, the better this control (as t
autopilot approaches an inertial system
the higher the possible rate of fire sin
the radio guidance period becom
shorter. This has the advantage
rapid fire with another important a
vantage: since there can be very acc
rate trajectory measurement, it is po
sible to attain a pre-impact predictio
of target damage very shortly aft
burn-out.

The prediction of where a give
successful warhead will detonate ca
permit deployment of a second missi
to a different target, which results
minimizing the total number of mi
siles required for accomplishment of
particular war plan—or, to express
another way, increasing the destructiv
ness of the entire missile force.

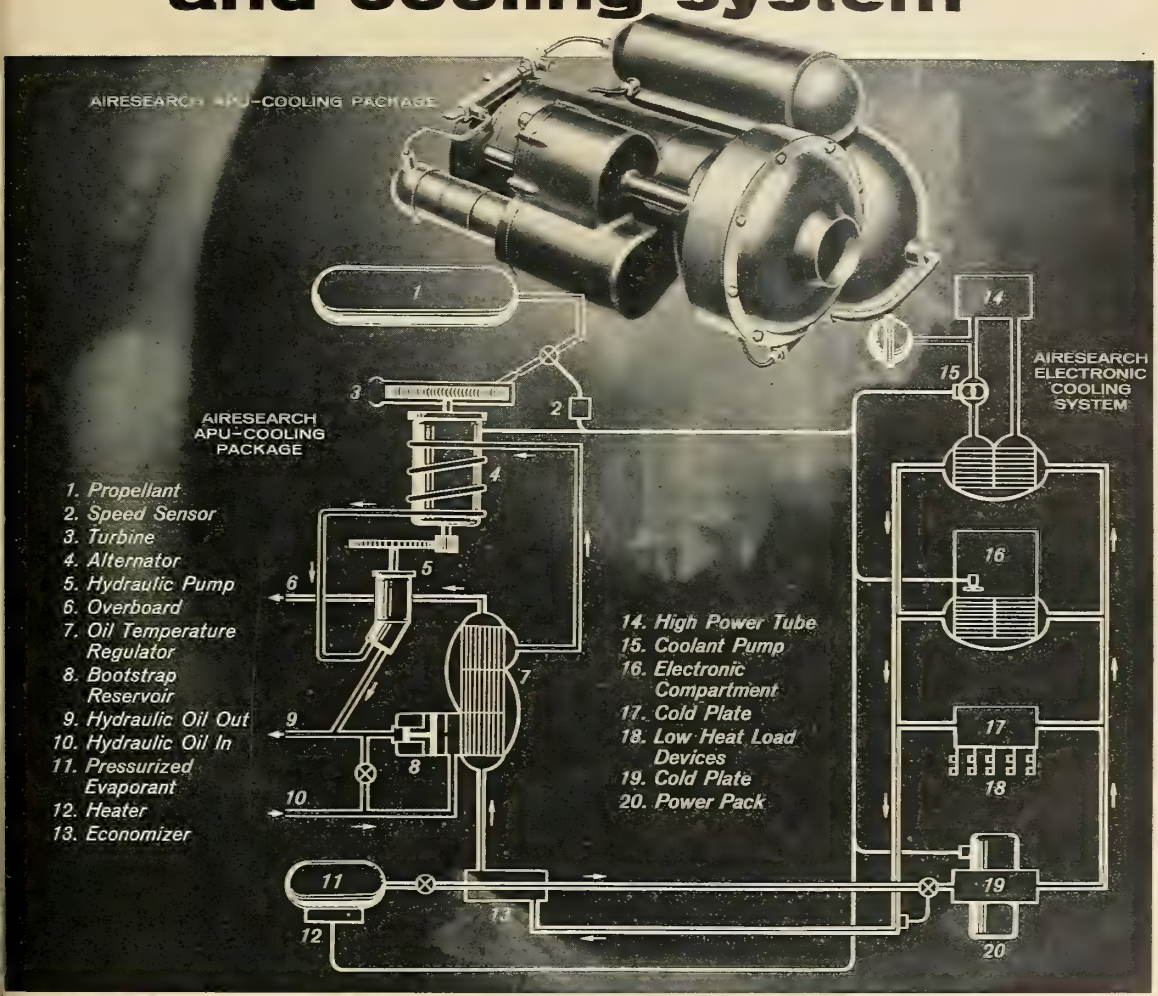
Another consequence of the con
mand link to the missile is the abilit
to "recall" (or destroy) a missile
flight. Conceivably, at some point
time, the ability to recall a missile cou
be the most important single influenc
on our very existence.

The function of receiving the co
mands from the ground, decoding the
and then acting on the commands a
the only functions that need be pe
formed by the missileborne equipme
other than those of retransmitting th
signals for the ground. As a result
placing all of the computation fun
tions on the ground along with the tr
jectory sensing devices, the airbor
portion of the system becomes qui
small and of light weight.

• **Weight and cost**—Considering
the requirements of an advanced sy
tem, a typical airborne system can
packaged in the space of 180 cub
inches. The weight of such a syste
protected against the rugged enviro
ment of today's missiles would be
mere 12 pounds. The total power co
sumption for such a beacon would
as low as 80 watts.

Another result of placing the mi
mum of equipment in the air is the c
of the airborne package. Thus t

# Integrated accessory power and cooling system




## meets the most advanced missile and space vehicle requirements

AiResearch has developed a *single* system package for missiles and space vehicles to meet increasing accessory power and cooling load requirements in the face of decreasing size and weight allowances.

This integrated accessory power and cooling system supplies hydraulic power for actuating systems, 3200 or 400 cycle three-phase electric power for guidance and control, and at the same time provides cooling both for the APU and all electronic equipment operating in the missile or space vehicle.

The cooling system in the example shown here uses liquid ammonia as the expendable evaporant, and each heat load area has a separate temperature control valve. Alternator and controls, turbine assembly and APU liquid propellant fuel tank are patterned after operationally proven components.

World leader in the design and manufacture of cooling and accessory power systems, AiResearch has delivered more missile APUs than any other company, and is the leader in advanced electronic cooling systems for aircraft, missiles and spacecraft.

AiResearch design and manufacturing experience in these two fields includes: liquid and solid propellant APUs; hydraulic and hot gas actuators and control systems; 3200 and 400 cycle alternators; cold plates; expendable and closed cycle gas and liquid cooling systems; cryogenic cooling systems.

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throw-away portion of the radio guidance system today is an order of magnitude less expensive and smaller than other systems programed for the future.

As advancements in the state of the art continue there can be more saving in the size, weight and cost of these packages. For example, the recently announced "micro" transistors, manufactured by several companies, point the way to size reductions of some circuits by better than 2:1.

• **Reliability**—The reliability of the airborne equipment is also helped by the simplicity of the radio guidance beacon. With considerably less equipment operating in the severe missile environment, the probability of failure is correspondingly reduced. As an example of this, the present *Atlas* airborne radio guidance has a perfect record of never having caused the abort of a missile.

As we have pointed out, the radio guidance system offers several definite advantages for the ICBM case. As the requirements of future systems become more stringent these virtues should become more and more evident.

In the case of extraterrestrial missions, radio guidance systems offer unique solutions to otherwise "unsolvable" problems. For successful arrival at a lunar or planetary destination, the accuracy and long-term correction capability of this technique is mandatory. When the problems of trajectory measurement over long periods of drifting in space are considered, it is clearly desirable that we have a system that does not continually add and accumulate its own errors. As a result, it appears that the future applications of radio guidance systems are bright and long.

If it is desired to have today, as well as in the future, a guidance system that adds a minimum of size, weight and expense to the missile—and at the same time has the highest achievable accuracy—radio guidance is clearly indicated. ⌗

## Inertial Guidance

*(Continued from page 29)*

by maintaining the system in continual erection and alignment with periodic calibration or realignments.

This approach, though not ideal, appears to be a practical solution for some near-future systems. Rapid warm-up from a cold start is an objective of future systems so that continual operation will not be necessary.

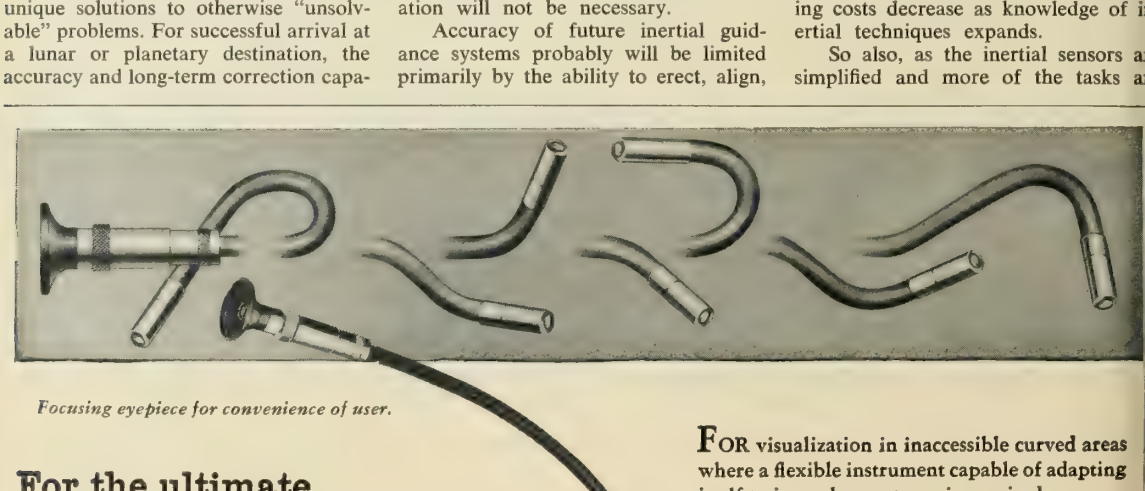
Accuracy of future inertial guidance systems probably will be limited primarily by the ability to erect, align, and calibrate them. The problem precisely erecting the inertial guidan system to a plane perpendicular to t local gravity is even today seconda when compared with the task of o taining initial direction for azimu alignment. In this regard, present o tical techniques impose significant o erational restrictions. However, the u of improved north-seeking gyros (gy compassing) to determine inert azimuth will soon become commo place.

We thus will have the ability erect and align completely the a inertial systems independent of any e ternal equipment; we will need on to insert initial position coordinate Response time will be limited chie by the need to warm-up and stabili critical components and by the enviro mental noise.

• **Cost, development time, and si** —The same trends which tend to ir prove reliability also will reduce co development time, and size and weigh

The major cost of today's all-i ertial system is in development tin and in the precise electromechanic equipment and precision electronic Both developmental and manufactu ing costs decrease as knowledge of i ertial techniques expands.

So also, as the inertial sensors a simplified and more of the tasks a

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shifted to the digital computer, there will be considerable reductions in cost, development time, size, and weight of the inertial guidance system. The ability of the inertial guidance system to operate in a self-contained manner and to check itself will save cost by eliminating the need for ground support equipment.

Inertial navigation and guidance has come of age. The practicality of this guidance method is accepted. The trend in the U.S. for highly accurate ICBM guidance systems has moved from radio alone, to radio with inertial as alternate, to inertial with radio backup, and finally to inertial alone. The advantages of the completely self-contained ICBM inertial guidance system apply also to other military applications from submarines, land vehicles, and aircraft to missiles, satellites, and space vehicles.

Closely related to the ICBM and of major significance is the launching of satellites and space vehicles where the inertial guidance system permits the selection of optimum trajectories. The savings in fuel will mean significant increases in overall pay load for the space vehicle.

What about future inertial guidance systems? A new line of inertial components is emerging: it will utilize air bearings, multi-axis flotation techniques, electromagnetic suspension, electrostatic suspension, or cryogenic suspension techniques. Some of these will not be operational for several years.

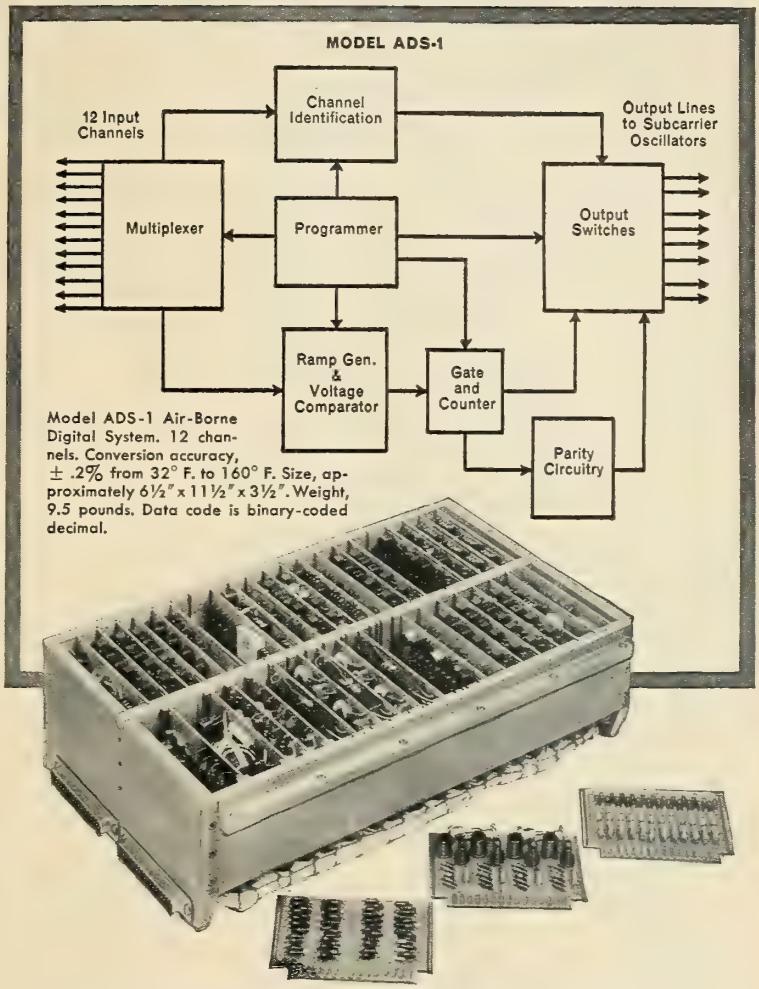
Much of the future effort will be directed toward making components more reliable and in reducing their cost, size and weight. The user of inertial guidance equipment can look forward confidently during the next 10 years to accuracies as good as he wishes.

The ultimate share of the guidance task between the radio and inertial systems will be determined largely by reliability considerations. When a man is in the spacecraft he will insist on having inertial guidance so that he will not have to depend on the idiosyncrasies of ground-based personnel or equipment.

However, he will want to have the assurance that the ground-based equipment can be used in case of an emergency. Radio guidance, then, will continue to provide a real service on applications where precise inertial equipment is not required or where the utmost in reliability for a single launching is a necessity. Such applications will include many of the space vehicle launchings during the next 10 years.

But, for secure, self-contained, accurate guidance of ICBM's with unlimited salvo capability and mission flexibility, inertial guidance must be the choice. ⌗


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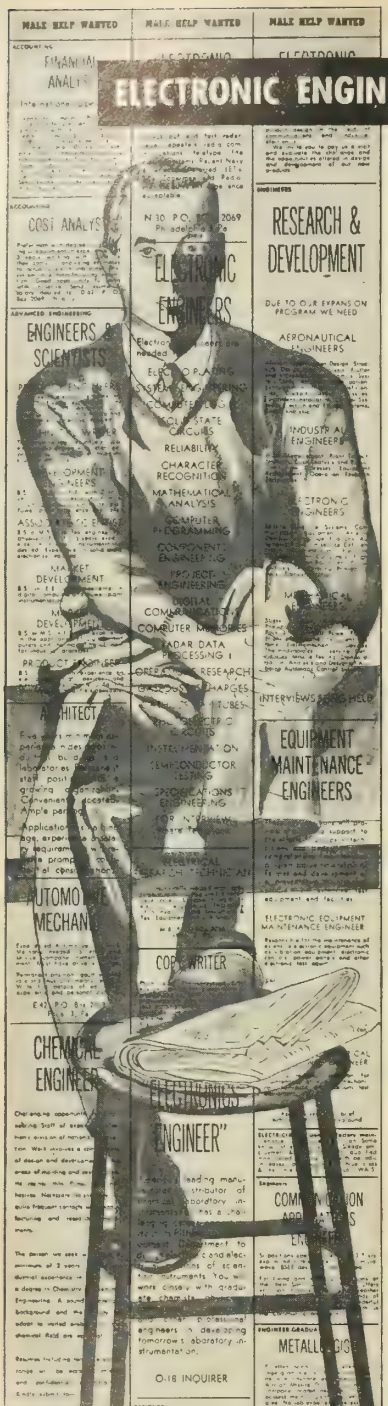
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**MR. D. E. DIMMIG**
***Employment Manager***

**PHILCO**
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**PHILADELPHIA 34, PA.**

# industry

## *Douglas Report Reveals Diversification Studies*

DOUGLAS AIRCRAFT Compan is studying several diversification ven tures, it was disclosed in a recent stock holders report.

No further details were given, bu there was some hint that the compan viewed electronics as a promising field The most recent move made by Dougla into other fields was the creation o Astropower, Inc., a subsidiary devote to research and development in ad vanced propulsion systems.

Although Douglas suffered a ne loss in the 1960 fiscal year, the com pany termed it "one of the company most outstanding years in terms of de fense business." Douglas copped severa coveted military projects, including th Navy's *Missileer* aircraft, the Air Forc *Skybolt* ALBM and a major contrac on the Army's *Nike-Zeus* antimissile missile.

Improvements and production con tinued on *Nike-Hercules*, *Honest John Genie* and *Thor* missiles.

The largest single National Aero nautics and Space Administration awar of the year was won by Dougla for the $68 million S-IV stage of th Saturn booster. The award called fo the design, development and produc tion of 10 of the second-stage vehicles The S-IV will be 18 feet in diameter about 42 feet in length and powered by four 70,000-lb.-thrust LOX-liqui hydrogen engines. Douglas plans to in crease its capability in the cryogeni field with the program.

The Douglas-built *Thor* enjoyed successful year as a space booster an prompted development on a mor powerful version. The rocket was re sponsible for 14 of the nation's tota of 16 successful satellite launchings i 1960. The company said the booste actually functioned successfully in 1 of 21 starts, but two launches failed be cause of malfunctions in other stage of the vehicles.

Satellites launched by *Thor* were NASA's *Pioneer V*, *Tiros 1*, *Echo* and *Tiros II;* seven Air Force *Di coverers;* two *Transits*, sponsored b ARPA and the Navy; and *Courier 1* sponsored by ARPA and the Army Douglas' *Delta* served as upper stage in the *Echo* and *Tiros* shots.

Forty-eight *Thors* have already bee ordered for future satellite boostin tasks. Included are additional *Di coverers* to be launched with the im proved *Thor*. The *Delta* will be use in 1961 for another *Tiros* meteo ological satellite and satellites designe

for deep space research, solar spectroscopy studies and radiation and atmospheric structure analysis. The company also holds a number of study contracts awarded by both the military and NASA, including one for the operations phases of the advanced *Saturn, C-2* system.

Losses in the past two years are attributed to the introduction by the company of an entirely new jet transport, the DC-8, to the market. Fourth quarter marks stayed in the black and brought the year's total to some improvement over 1959.

Net sales in 1960 were $1,174 million compared to $884 million in fiscal 1959. Net loss was $19.4 million, considerably less than the previous year's $33.8 million. The company enjoyed a fourth quarter profit of $2.4 million.

During the 1960 fiscal year Douglas trimmed its working force by about 16,000 employees—from 65,500 to 49,700 people. The cut decreased the payroll by $62 million. ⁂

## *General Precision Files Suit Against Martin Co.*

GENERAL PRECISION Equipment Corp. has filed an anti-trust suit against The Martin Co. of Baltimore, largest shareholder with about 15% of its outstanding voting stock.

The suit cites Martin with violation of Section 7 of the Clayton Act and asks that Martin be made to divest itself of its stock, and prohibited from increasing its holdings, voting its holdings or otherwise interfering. General Precision is also asking for damages and other appropriate relief.

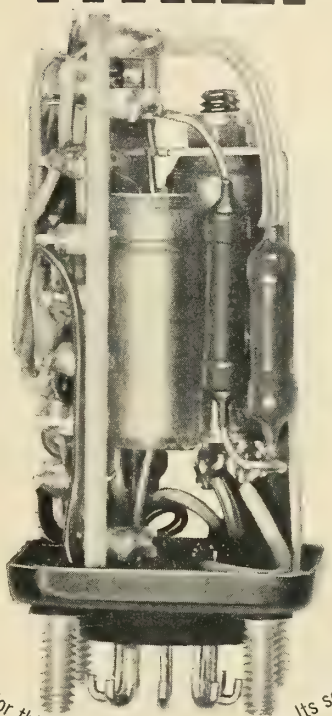
General Precision said the action was initiated after the company received a letter from The Martin Company demanding appointment of Martin's Board Chairman and General Counsel as Martin representatives on the Board. It also demanded removal of six present directors.

GPE Chairman James W. Murray noted that "Over 50% of the total business of the General Precision companies is done with competitors of the Martin Co., compared with approximately one percent with Martin . . . Any takeover of General Precision . . . can only have an adverse effect upon our business with its competitors."

Martin's sales in 1960 were more than $600 million. General Precision's sales were $244 million. ⁂

**RADIO CORP. OF AMERICA,** Electronic Data Processing Division has consolidated its administrative and home office personnel at company facilities in Cherry Hill, N.J. A product planning group, now at Pennsauken,


# 50-G WHIZ!



**RUGGED IS THE WORD** for this A. W. Haydon time delay relay. Its sealed relay will withstand shock up to 50 g for 11 milliseconds, and vibration up to 2000 cps at 20 g. It is also precise . . . with delays up to 120 seconds before starting or stopping. This little giant is our Series 31300 electronic time delay relay and you ought to know about it, particularly if you're in the missile field. ■ Every favorable adjective in the book has been used by our customers to specify one or another of our electronic time delay relays. Fixed or variable delays from a few milliseconds to days, weeks or months. Our solid state switches resist up to 150 g shock, vibrations up to 3000 cps at 100 g . . . accuracies run to 0.05% or better. We could go on. But if you will simply write for information about the Series 31300 or any other timing devices you need, whether electronic or motor driven, we will be happy to tell all.

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N.J., will be transferred in late spring. Manufacturing and engineering activities of the Division will continue at Camden, Palm Beach Gardens, Fla., and Natick, Mass.

**ELECTRIC AUTOLITE CO.** will open its third wire and cable plant to supply the missile/space and electronic industries next month at El Segundo, Calif. The plant will have a capacity of 500,000 feet per day. Autolite oprates three other plants on the West Coast.

**HUGHES AIRCRAFT CO.** is building a 35,000-sq.-ft. addition to its headquarters to handle increasing production and development requirements. The new building will increase facilities to more than 100,000 sq. ft. near Los Angeles International Airport.

**PICKARD & BURNS, INC.,** electronics subsidiary of Gorham Manufacturing Co. has planned construction of a 60,000-sq.-ft. R&D laboratory. The lab will occupy six acres of land in the Waltham R&D park on Massachusetts' Route 128.

## financial

**Telecomputing Corp.**—Record sales of $48.8 million were reported for the fiscal year ended Oct. 30, an increase of 27.4% from the previous year's $38.3 million. Order backlog was at a record year-end high of $30 million, compared to $27.7 million at the end of 1959. However, the company sustained a loss for the year of $273,272, compared to net profits of $1.9 million in 1959. The loss was attributed to a $2.1 million write-off on the Air Traffic Beacon Ground System and investments in research and expansions.

**Amphenol-Borg Electronics Corp.**—Net sales in 1960 were $60.4 million, up 6.9% over sales of $56.5 million. Earnings were $2.934 million, up slightly from the previous year's $2.926 million.

**The Gabriel Co.** is planning to sell its Electronics Division, which operated at a considerable loss during the past fiscal year. No details of the plan have been disclosed.

Gabriel President John H. Briggs said the losses sustained by the Electronics Division, combined with those suffered by the Bohanan Division, gave the company its first losing year in six years. The Bohanan Division has been consolidated with Rocket Power/Talco to preclude future operating losses.

The Gabriel president pointed out that the Automotive, Rocket Power, Talco and International Divisions operated at a profit, reducing the year's total profit loss to $436,556. The company's net sales were $31.2 million, topping 1959's record of $28.8 million.

**Lockheed Aircraft Corp.**—A net loss of about $43 million is forecast for the company, although the last six months were profitable with net for the period estimated at $12.5 million.

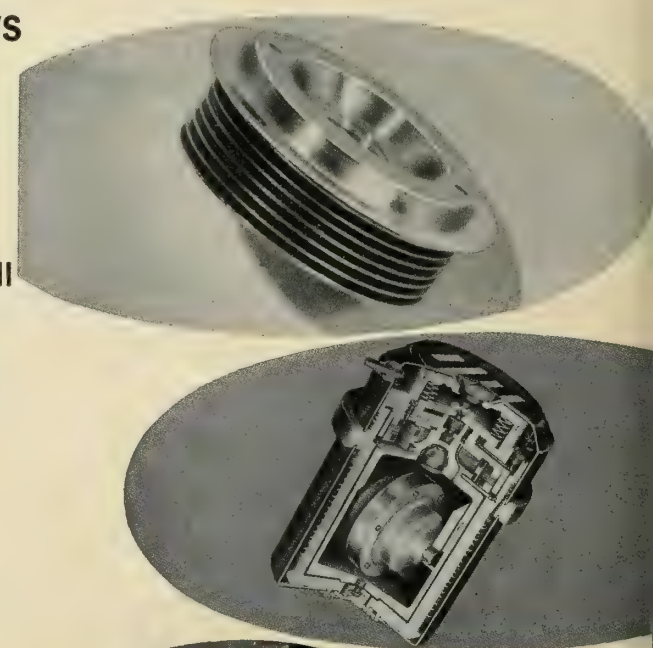
**International Resistance Co.** has entered the rapidly-growing semiconductor field with the purchase of North American Electronics, Inc. of Lynn, Mass. The company plans to add "substantially" to facilities to meet 1962 requirements.

**Astra Technical Instrument** will expand its facilities at Los Angeles to concentrate on design and manufacture of temperature measurement systems and components. The company also occupies manufacturing and testing facilities in Santa Ana, Calif.


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The complex new gas-bearing gyroscope shown here in a cut-away has a bell-shaped ceramic spin motor. Its interior spins at 24,000 revolutions per minute suspended on a film of helium gas only 25 millionths of an inch thick. The gyro weighs just 8 ounces, is 2.8″ long and 2.0″ in diameter.

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# names in the news

**Dr. Victor Twersky:** Head of researc at the Electronic Defense Laboratories c Sylvania Electric Products, Inc., promote to senior scientist. Internationally know for his work in the fields of electr magnetic wave scattering and propagatio he is one of three persons in the natio to achieve this position with Gener Telephone & Electronics Corporation, th parent organization.

**Col. Francis N. Miller:** Former chi of staff, U.S. Army Proving Ground, Fo Huachuca, Ariz., appointed head of fie engineering section at Electronic Defen Laboratories of Sylvania Electric Pro ucts, Inc., Mountain View, Calif.

**Ernest T. Andrews:** Of E. T. Andrew & Co., Hartford, Conn., and **Louis Resnik,** senior partner in Paskus, Gordo & Hyman, New York City, elected board of directors of Microwave Co poration of America, Stamford, Conn.

**Wayne D. Stinnett:** Appointed ma ager of newly-formed special produc division of Aerojet-General's liquid-rock plant, Sacramento, Calif., which man factures the *Titan* ICBM propulsi system.

**Dr. Sidney W. Kash:** Former manag of the plasma physics department Lockheed Missiles and Space Divisio Palo Alto, Calif., appointed supervisor the plasma and electron section in physi research at Armour Research Foundatio

**Rear Adm. Thomas G. Wallace, USN ret.:** Joins the advanced development se tion of Admiral Corporation in Pa Alto, Calif.

**Ellis G. Slack:** Appointed assistant the president of Gulton Industries, In Metuchen, N.J. Former general manag of Harvard Industries' frequency stan ards division at Asbury Park, N.J., also has been associated with Nation Electric Products in Pittsburgh and Am Aeronautical Laboratory at Moffett Fiel Calif.

**Paul W. Beamer:** Named manager product and sales development of n marketing group created by Wyma Gordon Co., Worcester, Mass., for e pansion in nuclear, power generation, a electronics fields. Other appointments this group are **Richard Benson,** produ manager, gas turbine applications; **Pa J. Wisniewski,** product manager for t nuclear and electronics applicatio **Martin A. Komertz, Jr.,** product manag for military sales and special produc and **Thomas U. Chace,** product manag airframe and missile applications.

**Dr. Michael J. DiToro:** Joins technic staff of Cardion Electronics, Inc., We bury, N.Y., as vice president for researc Former director of engineering at PR Electronics, Inc., Brooklyn, has bac

ground of more than 25 years in electronics and basic sciences.

**W. W. (Win) Harris:** Appointed administrative manager of the Datalab Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

**William Rympalski:** Appointed general manager of Telemetal Products, Inc., a subsidiary of Polarad Electronics Corp., Long Island City. With Polarad over 12 years, was formerly chief production supervisor at Polarad and manufacturing consultant to Telemetal.

**Raymond S. Fries:** Named general manager of ground support division of American Electronics, Inc. For 13 years prior to joining the firm, he held various management assignments with Minneapolis-Honeywell Regulator Co.

**John Manniello:** Promoted from director of marketing to vice president of CBS Laboratories, Stamford, Conn.

**Kerby H. Fisk:** Board chairman and chief executive officer of Allied Chemical Corp., elected director of Minneapolis-Honeywell Regulator Company.

**George A. Rohner:** Appointed New England district manager, with headquarters in Boston, for Kidde Aero-Space Division, Walter Kidde & Co. Inc.

**Ralph A. Escribano:** Former sales manager for Delta Design Engineers and president of Public Relations International in San Diego, appointed general manager of Instrumentation and Control Engineering, a division of Miles-Samuelson, Inc.

**William G. Dunn:** Former lead engineer of the acoustic test section of North American Aviation, Inc.'s Dynamics Laboratory, Columbus, Ohio, joins Tenney Engineering, Inc. as manager of new acoustics division in Union, N.J.

**Z. W. Pique:** Elected vice president-marketing of Statham Instruments, Inc., Los Angeles.

**Edgar M. Shurtleff:** Named director of research and development of Special Devices, Inc., Pacoima, Calif. Formerly was head, advanced design section, McCormick Selph Associates; senior engineer with The Martin Company and Asst. Prof. of math & physics at Salem College.

**Raymond H. Heller:** General manager of Robertshaw-Fulton's aeronautical and instrument division, elected assistant vice president of the corporation.

**Dr. Frank E. Sorenson:** Former executive secretary of The Link Foundation, New York, N.Y., elected chairman of the Technical Assistance Board. **Miss Marilyn C. Link,** former administrative assistant at General Precision Equipment Corporation, replaces Dr. Sorenson as executive secretary. **Dr. Wayne O. Reed,** Deputy Commissioner, U.S. Office of Education, appointed to the Technical Assistance Board.





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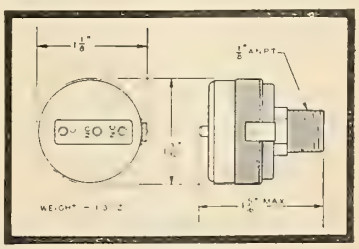
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# Missile/Satellite Defense Debated

## Three services have three answers to Soviet threat—Army tells Congress it should get go-ahead for Nike-Zeus, Air Force calls for satellites, Navy urges seaborne system

**by James Baar**

A POTENTIAL interservice bloodletting of large-scale proportions over missile and satellite defense is in the knife-honing stage.

All three military services—particularly the Air Force and Army—quietly drew up the battle lines this last week in an opening series of hearings before the House Space committee.

One by one the Pentagon's top R&D officials testified before the committee that the development of an active missile and satellite defense system is one of the most serious problems that the nation faces in the 1960's. Then each proceeded to stake a claim on how to do it.

–Richard S. Morse, Army Director of R&D, said the Army should be permitted to proceed immediately with limited production of the Western Electric *Nike-Zeus* antimissile missile.

–Lt. Gen. Bernard Schriever, commander of the Air Research Development Command, said the Air Force "believes an active (missile) defense system based on satellites offers the greatest promise."

–Rear Adm. Thomas F. Connolly, Assistant Chief of the Bureau of Naval Weapons, urged the development of a seaborne satellite defense system.

**• Why not 150 Red ICBM's**—Meantime, the threat of the growing Missile Gap was re-emphasized in the Senate.

Sen. Stuart Symington (D-Mo.), taking the floor to answer GOP statements that the Missile Gap is a fiction, said "there is a long-range Missile Gap today and there will be one for some time to come." He said the need for closing it "has been recognized" by the Kennedy Administration.

Symington said America's only long-range missile plant in production, if called upon to do so, could produce missiles at a rate of one missile per day." Then he asked pointedly:

"In view of this fact, is it reasonable for anyone to assume that an estimate of 150 missiles produced and deployed by the Russians over the past two years is far too high?"

Current informed U.S. estimates of Soviet missile strength range from about 50 to 150 ICBM's plus several dozen or more short-range missiles deployed aboard Soviet Conventional submarines. The United States today has about six to nine operational *Atlases* and 32 *Polarises* aboard nuclear-powered submarines.

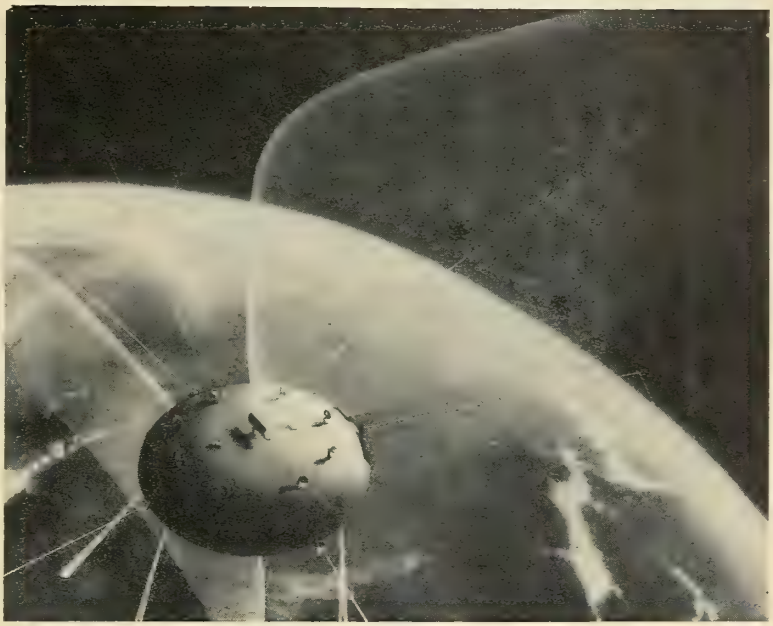
"To see where we are lacking," Symington told the Senate, "to admit it and to see about correcting it, is a mark not of weakness but of strength."

**• Zeus sparks fight**—The missile and satellite defense fight centers on the Army drive to commit *Nike-Zeus* to production.

Morse told the Space Committee that in the last year very substantial progress has been made on the *Zeus* effort. He said that "many of the difficulties with which we were faced—high-powered radars, development of very high-powered tubes, questions of fast take-off of the missile—have been solved essentially."

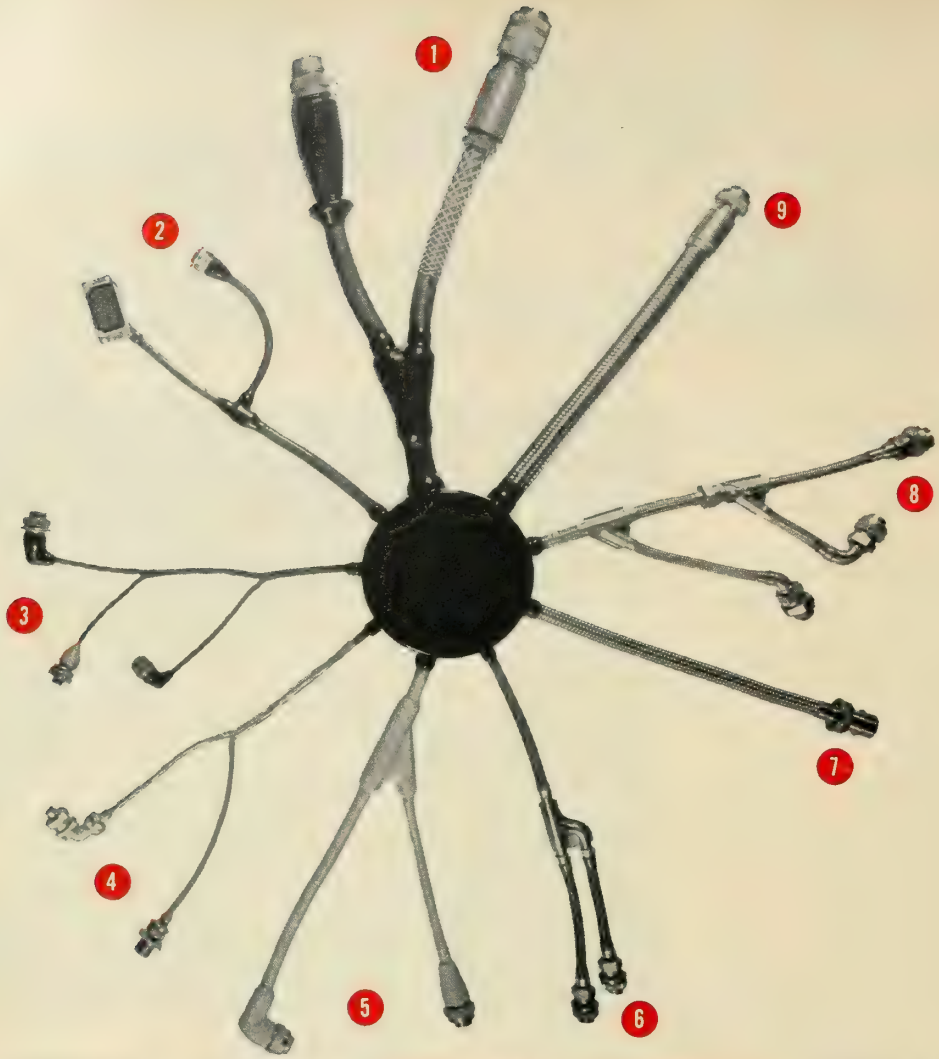
He urged that, in the light of this and the continuing "urgent requirement for an antimissile defense," the Army should be authorized to proceed with early limited deployment of *Zeus* in order to buy time.

The cost of such a program is estimated at about $270 million for the first 18 months (M/R, Jan. 30). At the end of the first year or so, the program could be greatly expanded without any loss of time. The full pro-



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ram sought by NORAD would cost bout $8 billion.

Morse noted dryly that the sum required for limited *Zeus* production in FY '62 "is a very small number compared with most programs (and) almost any Air Force program. . . ."

"*Zeus* is the only possible system which can be produced and deployed within the next decade," he added.

However, only a few days before Morse testified, the committee heard ar less than enthusiastic huzzahs for *Zeus* from Dr. Herbert York, Pentagon Director of R&E.

• **Red missile defense**—York said hat last year he was "not sold on going into production or deployment of he *Zeus* program" and this year he felt "the same."

"You want to see the thing perfected," one congressman asked him rhetorically. "There are still a lot of flaws that must be overcome and you are not ready to go into production."

"The question," York said, "is whether it will work at all."

Air Force officials testifying before the committee carefully avoided making any direct comment on the value of *Zeus*. When asked about the big antimissile missile, Dr. Joseph V. Charyk, Air Force Undersecretary, said:

"There is evidence that the Soviets are working toward a solution to the anti-ICBM problem. I think the anti-ICBM problem is one of the most important areas that we have."

Schriever said "defense against ballistic missiles is perhaps the most crucial area of development." He said, "If one nation develops one before the other it could give it a decisive edge."

Then, without commenting on *Zeus*, he said that on the basis of Air Force studies, an antimissile satellite offered the greatest promise to solving the problem.

The statement was a clear reference to recent Air Force studies of an active *Saint* satellite system. The initial *Saint* study being conducted by RCA for the Air Force called for only a satellite inspection system. An active *Saint* would be capable of both inspecting a satellite and neutralizing it if it were hostile. Such a system also might be developed to intercept ICBM's during the powered phase of flight.

An anti-missile satellite is part of overall Air Force plans for a military space program over the next 10 or 15 years. Charyk said these plans include satellites for communications, early warning and reconnaissance.

"Beyond these there are a whole series of activities," he said. He was not asked to elaborate. However, these "activities" are known to include both offensive and defense space systems that would be manned and unmanned. All are currently under study by a special committee set up by Schriever to survey military space possibilities through the middle of the 1970's.

Schriever told the committee he expected to receive the report about March 1. ⌗

## Defense Notes from the Capital

• More than 43% of the $773 million in projects included in the Military Construction Bill submitted to Congress for FY '62 are for missile facilities. The biggest slice is $251.9 million for ICBM bases. This item includes facilities for six *Minuteman* squadrons—300 missiles—and one mobile *Minuteman* unit. There are also funds for the last two *Titan II* squadrons—18 missiles—at Griffis AFB, N.Y.

• The Air Force disclosed that it is trying to develop a carbon cloud decoy to blind infrared missile guidance systems. The carbon cloud would form a screen that would prevent an IR detector from "seeing" a heat source. The Air Force believes that Russia is "very active in the infrared field."

• Here is how the space pie is now cut in the Pentagon. The Air Force has 87% of the programs. It spent 91% of the money for itself or others. The final Eisenhower budget provided a total of $850 million for military astronautics for FY '62. According to R&E Director Herbert York, this includes everything that can be identified with space and space support. The FY '61 budget provided only about $500 million; the FY '60 about $400 million. But these totals did not include a number of support items.

• Rear Adm. Thomas F. Connolly, assistant chief of the Bureau of Naval Weapons, handed Congress a list of "10 main astronautics endeavors that will provide direct and significant improvements to the nation's sea power." The list: A satellite defense system, tactical booster for naval operations suitable for sea launch, space surveillance system, reconnaissance satellite, navigation satellite, geodetic satellite, meteorological satellite, several communications satellites and a global ground environment for space operations. Connolly said the "tactical booster" could be a *Sea Scout*—a *Polaris A-1* plus the upper two stages of *Scout*, ABL 248 and ABL 254. He said the *Sea Scout's* payloads could be increased from 300 pounds to about 500 by using the *Polaris A-2* and *A-3* now under development. ⌗


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## *Three Astronauts picked . . .*

# Man-in-Space Passes 'Milestone'

MANNED ORBITAL flight in 1961—a goal discounted by the U.S. for the last several months—once again seems possible as the result of last week's completely successful *Mercury Atlas* 2 flight.

Jubilant officials of the National Aeronautics and Space Administration—who breathed a collective sigh of relief as the *Atlas* passed safely through its "max Q" at T + 60 seconds—declared that major slippage in the *Mercury Atlas* program now seems ended by the *Atlas* fix.

*Mercury* director Robert R. Gilruth called the flight a "successful and very significant milestone" and promptly chose three astronauts for final training for the suborbital *Mercury Redstone* flight a month or two hence.

Three changes were made to beef up the front end of the *Atlas* and the interstage area between booster and capsule:

–The adapter ring was strengthened by addition of cross-members and stringers (longitudinal members).

–The fore portion of the *Atlas* was strengthened by adding an 8-in.-wide stainless steel band, of about the same (classified) thickness as the missile skin itself.

–The elbow-shaped oxygen vent valve atop the *Atlas* LOX tank was given a new kind of bracing.

The booster and capsule came perfectly through the high air loading (Q) on the upward flight that apparently caused explosion of the first *Mercury Atlas* last July 29 and the *Atlas-Able* lunar probe Dec. 14. Officially, however, the cause of both explosions has never been found.

The capsule itself came down unscathed from buffeting of up to 16½ g, more than twice the normal re-entry load. Gilruth said there is no doubt a man would have survived the flight, which duplicated the most severe re-entry path the capsule could take after emergency abort during an attempt at orbital launch.

In addition to doubling the g load, the flight provided 30% higher re-entry heating rate, temperatures 25% higher on certain capsule points and three times the normal re-entry air load—up to about 900 lbs./sq. ft. Inside the capsule, however, temperature never went over 90°F—that of a warm summer's day.



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Performance was so close to nominal that sources at NASA headquarters said there is little need to examine the telemetry to be certain that MA-3, the next *Mercury Atlas* flight, will proceed to the next experiment—injection of an empty capsule into orbit and immediate re-entry command. The flight will take place a short time after the Air Force delivers the first of its strengthened *Atlases*, with skin about double normal thickness at the front end—similar to those the AF has been using on *Samos* and *Midas* launches.

NASA used a thick-skinned *Atlas* on its *Big Joe* flight Sept. 9, 1959. However, thin-skinned *Atlases* were diverted from missile production lines and used for MA-1 last July and the two unsuccessful *Atlas-Able* vehicles used to attempt lunar orbit in 1960.

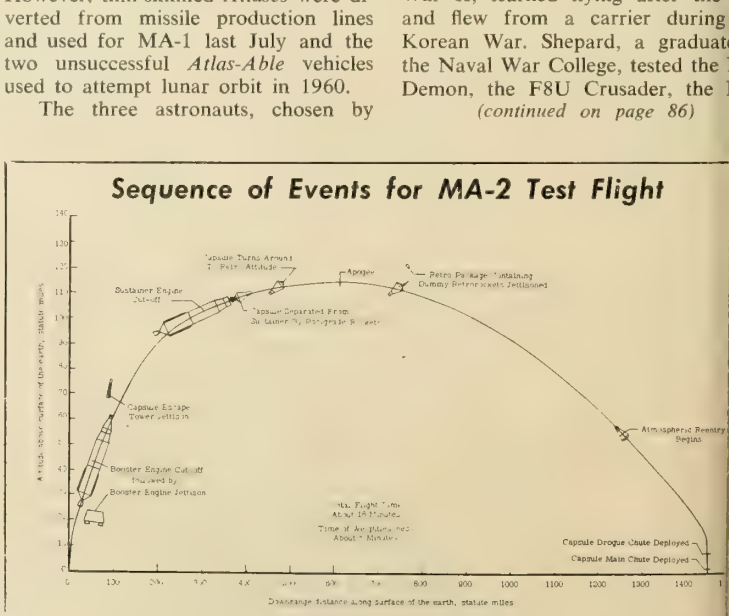
The three astronauts, chosen by Gilruth, include one test pilot each f the Marine Corps, the Navy and Air Force.

The Marine is Lt. Col. John Glenn Jr., 39, oldest astronaut ar hero of two wars who has been awa the Distinguished Flying Cross times and the Air Medal with clusters. In an F8U fighter in July 1 he set a Los Angles-New York s record of 3 hours 23 minutes, in first transcontinental flight to ave supersonic speed.

The Navy man is Cmdr. Alar Shepard Jr., 37, an Annapolis grad who served on a destroyer in W War II, learned flying after the and flew from a carrier during Korean War. Shepard, a graduat the Naval War College, tested the Demon, the F8U Crusader, the

*(continued on page 86)*

### *Sequence of Events for MA-2 Test Flight*



*Life shortened . . .*

# Transit III-B Qualified Success

***Failure of payloads to separate from upper stage will limit its usefulness; operational target date of 1962 remains unchanged***

THE 1962 TARGET date for an operational navigation satellite system still stands despite only "limited" success in last week's launch of *Transit III-B*. The *III-B* and its pickaback *LOFTI* satellite failed to separate from their second-stage booster and all three vehicles went together into orbit.

Scientists at Applied Physics Laboratory, Navy's system contractor for the navigation satellite program, said principal result of the separation failure would be a much shorter life—a few weeks instead of the hoped-for three years. Otherwise, the satellites will accomplish their objectives to at least a limited degree.

Instead of the intended 500-mile high circular orbit, the satellites and their booster case were injected into an ellipitical orbit with a 617-mile apogee and 104-mile perigee on Feb. 21.

*Transit III-B*, the third to be put into orbit, carried for the first time a new magnetic memory unit—a key component in the future operational system. This unit, as well as other payload equipment, was "working 100%," according to APL. Radio signals were "slightly impaired," however, apparently due to interference with antenna wave patterns.

This signal impairment will have considerable effect on the *SECOR* experiment planed for the mission. The *Transit* carried a transponder to be used with the *SECOR* electronic measuring system (M/R, 5/16/60) to provide Army map makers with precise geodetic position data.

Signals were also being received from the 54-pound *LOFTI* although, here again, their poorer quality may degrade their usefulness. The smaller satellite was to be used to study transmission characteristics of very low frequency (18 kc) radio waves through the ionosphere.

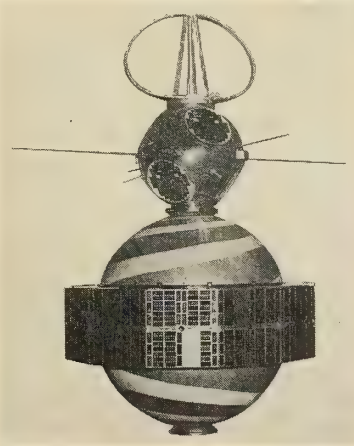
*Transit III-B* was boosted into orbit by an AF *Thor Able-Star*, the same rocket used for previous *Transit* and *Courier I-B* launches. Navy is currently campaigning for authorization to use a *"Sea Scout"*—two-stage *Polaris* with two *Scout* stages—as a launch vehicle for operational *Transits* which will weigh 50-100 pounds. They say present launch vehicles cost about $5 million each while the *Sea Scout* would cost less than $1 million per shot.

The present *Scout* vehicle—which saw its first space success Feb. 16 (see story, p. 84)—in fact, already uses an "old" *Polaris* for its first stage. The second stage is a modified Army *Sergeant* and the third and fourth are motors developed by Hercules Powder at Navy's Allegany Ballistic Lab.

Once in orbit, the satellite's spin was stopped by a magnetic damping system proved out on earlier models. An internal permanent magnet causes the satellite to align itself along the direction of the earth's magnetic field to properly orient the belt of solar cells with the sun.

Payload equipment includes two ultrastable oscillators each capable of transmitting continuously on four frequencies: 54, 162, 216, 324 mc for *Transit;* 224, 421, 448 mc for SECOR.

The use of four coherent frequencies from the same oscillator is an innovation in III-B. Since the signals emanate from the same source, scientists will be able to obtain a more accurate comparison of the signals in the study of ionospheric refraction of satellite signals.



*PICKABACK LOFTI rode Transit into space but failed to go into separate orbit. Visible external elements on 54-lb. satellite are loop receiving and telemetering antennas, solar cells, and earth and solar aspect detectors.*

Other equipment includes four transmitters, antenna (painted silver spiral band on exterior), solar cells, memory system and time signal, nickel-cad batteries, and the SECOR transponder.

The pickaback LOFTI contains a telemetry system (5 FM/AM channels), transmitter, command receiver, two VLF receivers, antennas, and solar-cell power supply.

LOFTI is instrumented to receive 18 kc signals from Navy radio station NBA in the Panama Canal Zone and measure the intensity of the signals in the ionosphere and exosphere. It will also measure VLF energy from lightning discharges. Data received by the satellite will be transmitted via telemetry to special mobile ground stations in Texas, California, and Panama.

This launch also marks the first use of a data injection station which would be used in the operational navigational system. The station, at Applied Physics Laboratory, beams the predicted orbits of the III-B to the experimental magnetic memory in the satellite. The III-B returns the data to stations on the earth, providing them continually with its current orbital data. The III-B will be the first satellite to broadcast its own precise position to earth. This information will be used by ships to make their own navigational fixes.

New orbital data will be fed to the satellite approximately every 12 hours. New data erases the old. The satellite's new intelligence is checked against the master memory in the injection station and another half-day of orbital broadcasting commences. Broadcast interval is once every 11.18 seconds. The memory and its transmitters are triggered for each read-out by a pulse from a frequency divider—a series of 25 transistorized circuits.

The counter digests the three million pulses a second coming from the ultrastable crystal oscillator, and reduces them to one precise and extremely accurate sparking signal. This pulse beamed in strength from the satellite directly to earth could be used as a near-absolute time standard accurate to the same precise degree anywhere.

The III-B has a more powerful and reliable power source than previous *Transit* satellites. ⁂

# Discoverer Advances on Five Fronts

***Only setback is failure to recover Discoverer XX capsule; bonus comes in success of Midas tracking***

THE AIR FORCE *Discoverer* program had five significant new achievements and one less significant failure on its record this week. The credits:

–First restart of an *Agena B* engine in space with *Discoverer XXI*.

–Heaviest satellite yet orbited in the series, the 2,450-lb. *Discoverer XX*.

–Use for the first time in the program of a modified fuel for the *Thor* first stage, upping thrust from 150,000 lbs. to 165,000 lbs.

–Successful multiple tracking test for the *Midas* program.

–Launch of two *Discoverer* satellites within a 27-hr. period.

The failure: Unsuccessful attempt to return the *Discoverer XX* capsule, due to an equipment malfunction in the satellite.

In view of previous successful recoveries, program personnel did not consider this a major setback, although it might affect the date of the first *Discoverer* monkey shot. Some sources said this was scheduled for *Discoverer XXII* next month.

"Telemetry data is being analyzed to determine the cause of malfunction," Ballistic Missile Division reported.

*Discoverer XX* was launched from Vandenberg Air Force Base at 12:25 p.m. on Feb. 17. Next day, at 2:58 p.m., *Discoverer XXI* roared aloft.

The double launching gave the Air Force the first opportunity to test its multiple tracking capability for the *Midas* program.

"This seemed a good time to see what we could do," a program officer said. The tracking test was a bonus, not a result of special scheduling. However, launch of *Discoverer XXI* was delayed about three hours to provide telemetry spacing for the two satellites. Previous *Discoverer* launchings had been spaced at least six days apart.

*Discoverer XX* was not scheduled as a *Midas* experiment although both satellites employed the second stage Lockheed *Agena B*. The recovery effort was the longest yet planned.

BMD did not announce immediate whether the attempt to eject the capsu failed or whether it was lost after eje tion. The satellite itself is expected remain in orbit up to six months.

The experiment was part of a co tinuing program to develop a "spac bus" testbed for a variety of oth experiments, including the long ove due effort to put a small monkey in orbit.

Apogee was given at 400 mile perigee, 201.9 miles; period, 95 minutes.

*Discoverer XX's* first stage was 56-ft., 108,000 lb. *Thor* DM-21 wi a block two engine employing for th first time a modified RJ-1 fuel slight denser than standard kerosene ba propellant. Thrust developed was 165 000 lbs.

The second stage was standard dimensions, 25 ft. in length and 5 f in diameter, but weighed 15,800 lb at launch compared to 15,500 lbs. f the *Discoverer XXI* second stag Thrust was the same at 15,000 lbs.

First test of the *Agena B* resta capability in orbit was made with *Di*

*(Continued on Page 86)*




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# NASA May Ask for Extra $200 Million

THE NATIONAL Aeronautics and Space Administration is considering a request to President Kennedy for 1962 budget increases to speed and increase the scope of *Saturn, Centaur,* nuclear propulsion, the F-1 engine, lunar and planetary exploration and meteorological satellites.

NASA headquarters has tentatively decided to reject a proposal by its launch vehicle office to spend $10 million in the coming year on a start on a giant segmented solid booster rocket.

The wind may blow either way on the biggest project involved in the space agency's budget discussions—the Project *Apollo* three-man space capsule.

The odds are that funds will be sought above the Eisenhower budget for *Saturn, Centaur,* nuclear propulsion, the F-1 engine, lunar and planetary exploration and meteorological satellites. The exact amount has not leaked out of the highly confidential discussions, but a good guess on the total might be $150-$200 million over the Eisenhower budget, exclusive of whatever is done about *Apollo.*

The *Saturn* funds will go almost completely for speeding the C-2 vehicle. *Saturn* C-1, the first, three-stage version of *Saturn,* seems to be just about fully funded. Extra money could speed the development of the J-2, 200,000-lb.-thrust liquid hydrogen engine at Rocketdyne, and might make it possible to award a development contract sooner on the giant S-II stage, a cluster of four J-2 engines. The Eisenhower budget provides only $3.1 million for the C-2, which provides for only a month or two of contractor work, late in the fiscal year, on the S-II stage.

Additional money for *Centaur* could authorize overtime work at Convair and Pratt & Whitney to speed the final phase of development, and authorize procurement of more vehicles when the development is complete. It also could speed up some of the supporting research in other places.

Nuclear propulsion development could be accelerated by providing money for engine hardware work during FY '62. And, if there were desire to go full speed in developing nuclear propulsion, parallel work could be started on the vehicle with an airframe contractor.

The F-1 engine—which may provide the basic propulsion unit for the manned lunar mission—could be speeded by authorization of overtime at Rocketdyne.

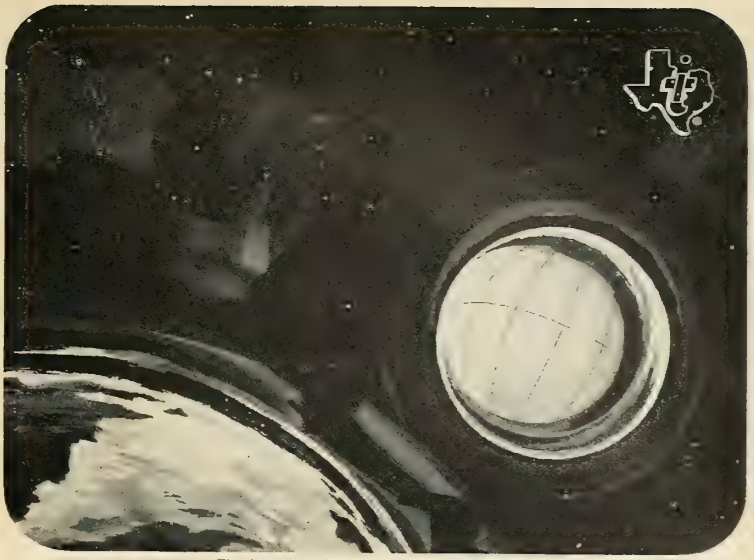
NASA headquarters officials feel the number of lunar and planetary launches on the program is strictly nominal. Additional money could provide more backup vehicles and payloads and more frequent shots. They caution, however, that the effect of speeding the program can't be felt for at least a year. It takes that long to schedule booster production.

The question under meteorological satellites is how fast to move into an operational system. The Weather Bureau and other operational weather data users are enthusiastic about the results of the first two *Tiros* shots. They want to have satellites up on a year-round basis. So far, under the Eisenhower budget guidelines, NASA has been unable to do that much. Under the new administration, it will be able to do more.

The NASA headquarters reasoning on the big solid rocket is that one more interim step should be performed before developing a booster as big as the F-1. The $3.1 million in the Eisenhower budget will provide funds for the interim step—a single segment weighing perhaps 60,000 or 70,000 lbs.

The question on *Apollo* does not revolve around technical questions. NASA is hesitant to propose speedy development of the big manned spacecraft—although it is already on the public record in favor of doing so—because it does not yet know the attitude of the Kennedy administration toward manned space flight.

Many members of President Eisenhower's Science Advisory Committee were opposed to carrying man-in-space beyond *Mercury* because of the great drain they said it imposed on the nation's scientific resources. The same scientists, although with a different chairman, are advising President Kennedy. There is still no word on Kennedy's attitude. ⁂

TI electronic flight control in Douglas Aircraft's Delta launch vehicle helped orbit the NASA communications satellite ECHO I.

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APPARATUS DIVISION

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## Silo Accident Cost May Hit $300,000

DAMAGES UP TO $300,000 may have been caused when a huge crane exploded and fell into an *Atlas* silo at Roswell, N.M.

The Feb. 16 tragedy took the lives of six workers and injured 13 others.

The property damage figure is a preliminary rough estimate by the Army Corps of Engineers. The final figure will not be known until two boards of inquiry complete their reports, perhaps this week.

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NASA Flight Research Center offers career positions that assure significant participation in the nation's space exploration program. NASA Flight Research Center activities include the current X-15 flight program and the Dyna Soar-1 development program, operational analyses of future projects such as manned terminal rendezvous and space station construction, vehicle characteristics studies, and supersonic transport.

Opportunities exist for graduate engineers and scientists with two to three years experience in the following aerospace fields: **Inertial Guidance, Servo-Mechanisms, Radar, Telemetry, Communications, Aerodynamics, Structural Heat Transfer, and Aircraft Systems.**

NASA Flight Research Center is located northeast of Los Angeles in California's beautiful Antelope Valley. Many avocational activities are available nearby, including deep sea and fresh water fishing, skindiving, sailing, snow and water skiing, and hunting. The Pacific, Lake Arrowhead, Apple Valley, Sequoia National Forest, Palm Springs, and Las Vegas are all within short driving distance.

**Inquiries should be addressed to:**
*Personnel Director, Dept. 123*
*NASA Flight Research Center*
*P. O. Box 273*
*Edwards, California*

**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

# Explorer IX—First Satellite Orbited by All-solid Vehicle

VISUAL AND photographic sightings of *Explorer IX*, a 12-ft. balloon satellite, are enabling scientists around the world to figure the density of the thin atmosphere between 400 and 1600 miles altitude.

Failure of a radio beacon will make it harder to track the aluminum-coated plastic sphere. But its reflectivity of 80% makes it as bright as a fourth-magnitude star while it is out of the earth's shadow.

Even more important than the satellite experiment were two important firsts chalked up by the *Scout* launching vehicle on Feb. 16:

–It was the first satellite ever put into orbit with an all-solid-propellant vehicle—a powerful argument in support of the current proposals for a big solid-propelled space booster.

–It was the first satellite launched from the civilian-operated Wallops Island, Va., station of the National Aeronautics and Space Administration —evidence that scientific satellites can be launched from a small installation with relatively inexpensive facilities and a small permanent staff.

• **'Poor man's model'**—*Scout* has been dubbed the "Poor Man's Rocket" because it is the first with orbital capability whose launching cost is expected to be under $1 million. That figure does not, of course, include development costs.

The orbital attempt succeeded on the fourth launching of a full four-stage vehicle and the second attempt at orbit. The *Scout* is now halfway through its development program, which is to be completed with four more launches in the next 12 months.

Payloads to be carried by the next four *Scouts* are *S-55*, a micrometeorite measuring satellite; and *P-21* and *P-21a*, two space probes for measuring electron density. The fourth will be a vehicle for back-up in case one of the others fails.

The *Explorer IX* payload weighed 87 lbs., of which 14 lbs. was the inflatable satellite and 73 lbs. was the satellite ejection and inflation equipment, the fourth stage telemeter system and such necessary hardware as the metal container in the nose of the fourth stage. The rocket case and payload container, which followed the sphere into orbit, weighed about 130 lbs.

The aluminum-plastic material of the sphere is 0.002 in. thick, about four times as thick as the skin of the *Echo* 100-ft. balloon satellite, and thus considerably more rigid. NASA said the 12-ft. *Explorer IX* sphere is expected to retain its rigidity even when pierced by micrometeorites. *Echo*, by contrast, has become quite wrinkled in the six months since it was launched.

The material consists of two layers of Mylar and two of aluminum foil each about 0.0005 in. thick, bonded into a four-ply arrangement with the aluminum on the exterior. A 2¼-lb. 3 in. by 4 in. radio beacon, powered by 280 solar cells and miniature storage batteries, was to have aided in tracking. However, the radio failed on the first circuit of the earth, somewhere between Woomera, Australia and San Diego, Calif.

Fortunately, however, NASA scientists had decided to add a small battery-powered tracking beacon to the fourth-stage rocket. This radio operated and provided the first confirmation that the rocket case was in orbit. It was not until late on the afternoon of Feb. 17 that it could be confirmed through optical and photographic sightings that the balloon itself was in orbit.

The orbital life of the balloon may be anything from a few weeks to a year. It depends on the exact density of the atmosphere at its altitude—something science does not yet know. The orbit has the programed perigee, but apogee is over 300 miles higher than the 1275 miles programed.



*SCOUT LIFTS Explorer IX into orbit in successful Feb. 16 firing at Wallops Island*

# Aerospace Aims to Triple Technicians

LOS ANGELES—Upcoming decisions to be made by the Kennedy Administration will determine the extent to which Aerospace Corp.'s role will affect industry-Air Force relationships.

Dr. Ivan Getting, president of Aerospace, said the firm establishment of roles and missions in carrying out space activities will be necessary before an estimate of his company's eventual future size can be made.

In its basic function as a third party in industry-Air Force intercourse, Aerospace will exercise less detailed control of programs than that practiced by Space Technology Laboratory during its tenure in a similar role. Dr. Getting subdivided his organization's operations into three segments: Advanced planning, systems research, and general systems engineering and research.

"Aerospace is to be the technical arm of the Air Force in the fields of ballistic missiles and space systems," he said, declining to specify all the programs now "in-house."

"A three-fold increase in technical personnel is desirable, before we can hope to be in reasonable control of the job we have been asked to do," he continued. The company now employs about 2000 persons, of whom 400 are technical personnel and the remainder administrative and support.

• **Workload**—About 20 programs and projects are now under Aerospace's cognizance, 12 having been inherited from STL last summer when Aerospace was formed. With the acquisitions, Aerospace also got about 250 STL people. The firm is also conducting studies in applied research management.

Included in the 20 programs are *Dyna-Soar, Advent, Midgetman* ICBM, *Saint, Midas, Samos, Mercury, Transit, Bambi* and *Vela Hotel,* among others of a classified nature. The *Transit* satellite launch scheduled for later this month will be the first Aerospace-managed space shot, Dr. Getting said.

The third-party role of Aerospace is expected to make some very complex contractual arrangements, due to the fact that the responsibility of a contractor cannot be spelled out as specifically as sometimes desired, Dr. Getting said.

"Aerospace will provide technical supervision and other assistance to the Air Force, without diminishing the responsibilities of the contractors to perform as required," he said, adding that some companies are in extremely competitive positions and therefore are not always candid.

He likened his company to an architect-engineer in the weapon system development field.

Contractural clauses arrived at by Aerospace for inclusion into future agreements will carry forward an established practice set forth by STL in its relations with industry.

In its technical direction of Air Force programs, Aerospace will spell out contractor responsibility, define interface areas and make various subsystems compatible. This technical direction he defined as the job of modifying contractor activity to the benefit of the Air Force.

The degree of direction will not be as high as that practiced previously, Dr. Getting pointed out, estimating that Aerospace expects to assign about 40 to 50 technical personnel to each major program, whereas STL had about 250 people per program. Aerospace will get into extremely fine detail only where absolutely required, he added, comparing Aerospace's role for the future with that role filled by STL through 1957.

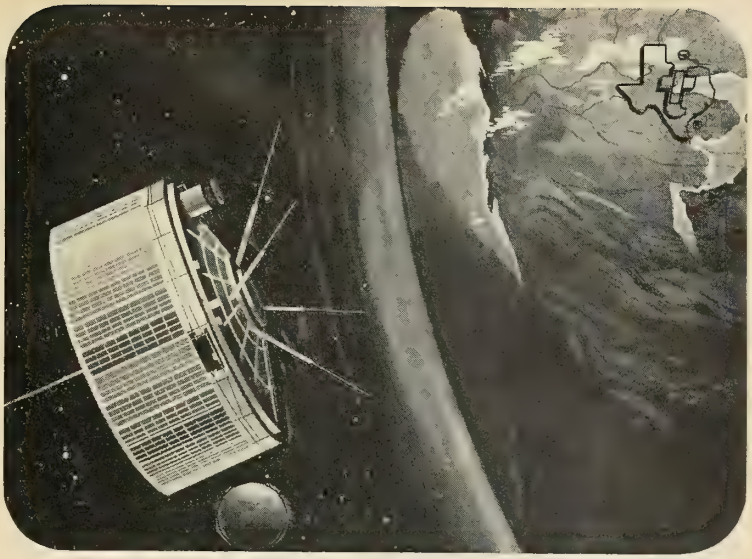
• **Teers**—Aerospace's laboratories will check out conclusions drawn by other organizations in connection with Air Force programs.

"It is not that these other organizations are considered incapable of drawing proper conclusions," he emphasized, "but if we are to function properly here, we must treat others as peers, and in turn be treated as a peer.

"So, even though scientists as a whole are quite rational and objective, they are, after all, human beings and therefore susceptible to becoming salesmen for their own concepts and systems. We merely want to insure that the semantics and other terms of reference are defined in the same manner by all parties," he stated.

In addition to its monitoring functions, Aerospace will also conduct its own original research work. As an example, Dr. Getting noted that physicists at the company had recently achieved a ten-microsecond plasma of about 300,000 degrees.

Another possible field of interest is one suggested by Trustee Trevor Gardner at a recent board meeting of the company. Gardner advocated that Aerospace support research into the use of outer space as a medium for arms control on earth. Dr. Getting indicated this might be done, and said he sees no contradiction between this and the firm's role as an arms maker.

TI electronic flight control in Douglas Aircraft's Delta launch vehicle helped orbit the NASA weather satellite TIROS II.

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A celestial navigation system called for a tracking device capable of establishing a line of position within an accuracy of 300 feet. Kollmorgen came up with a constant deviation elevation system that positions a movable mirror, in relation to the fixed elements, to a repeatable accuracy of better than 5 parts in a million.

This compact package represents a combination of highly precise optical and electronic units in a housing only 6 x 6 x 10 inches. Kollmorgen's project from concept to installation, it is a typical demonstration of the company's scientific, engineering and manufacturing skills in optics, electronics, mechanics. Example: the precision optics (a prism and two mirrors) are of Kollmorgen manufacture. So, too, are the Inland torque motor*, the gearing and other precision-machined parts.

Our motive in this message: Kollmorgen offers proven capabilities in optics, electronics and precision machining of metal components . . . capabilities which could solve your problems in missile tracking, fire controls, navigation, or . . .?

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## Two Discoverers

(Continued from Page 82)

*coverer XXI*. This was with the last of the *Midas* experiments in the program.

The liquid fuel engine, developed by Bell Aerospace, was restarted for one second during its first pass over the Pacific Missile Range. This occurred about two hours after the 2:58 P.M. launching from Vandenberg AFB.

Designed for a useful life of only two days, *Discoverer XXI* did not carry a recovery capsule. Computed orbital life is about 150 days, according to the Air Force.

The engine restart is believed to have required less than 100 lbs. fuel during the brief burning time. The vehicle was rotated 180° following restart to reverse its position.

Success of the restart operation demonstrated the ability to perform evasive action with a *Midas* satellite as well as making orbital corrections.

Except for the restart experiment, *Discoverer XXI* was a carbon copy of *Discoverer XIX*, launched Dec. 19, 1960. Test objective for both vehicles was the collection of engineering and research data on the atmospheric phenomena and infrared radiation in the earth's atmosphere. Data obtained will be needed to support the advanced *Midas* R&D program.

The first stage developed 150,000 lbs. thrust with standard RJ-1 fuel.

Period of the test vehicle was lengthened four minutes to 97.8 min. following restart with an apogee of 670 miles and 155-mile perigee.

The Air Force listed six major test objectives for the *Discoverer XX* experiment:

(1) *Agena B* systems evaluation, including launch techniques, propulsion, communications, orbital performance, recovery techniques, advanced engineering tests, special attention to proving reliability of re-entry, recovery techniques.

(2) Evaluation of stabilization-system modifications made to overcome instability problems of some previous *Discoverer* flights.

(3) Improvement of all systems reliability to achieve 4 days in orbit before recovery.

(4) Evaluation of components in the radio command guidance system.

(5) Radiation background measurements.

(6) Determination of high energy protons effects on silicon test materials (to check space radiation on transistors and solar cells).

The 300-lb. re-entry capsule contained—in addition to the usual communications and command equipment—a precision Navy Transit tracking beacon in a joint Navy-AF experiment to further evaluate the Transit satellite tracking technique. Two Navy transmitters provided signals for Doppler shift experiment.

## Mercury Success

(Continued from Page 80)

Skyray and the F11F Tigercat before becoming project test pilot on the F5D Skylancer and an instructor at the Navy's Test Pilot School, Patuxent, Md.

The Air Force man is Capt. Virgil I. Grissom, 34, who flew 100 combat missions with F-86s in Korea, for which he was awarded the Distinguished Flying Cross and Air Medal with Cluster. He was a jet pilot instructor from 1952 to 1955, studied aeronautical engineering for a year and then became a test pilot in 1957.

Gilruth said he chose the three astronauts on the basis of evaluation of medical and technical information accumulated during the initial pilot selection process and the 22-month training program.

He pointed out that all seven astronauts will be eligible for selection for later ballistic and orbital flights, on the basis of similar evaluations. All seven will work together during actual flight operations—the six remaining men on technical support and communication assignments.

The final selection of the astronaut for the manned *Redstone* flight will be made just before the flights, Gilruth said. It was understood the three will be narrowed to two about 48 hours before the flight and that the third astronaut will be assigned to voice communications at Grand Bahama Island. Both of the remaining men will prepare for the flight, so that the second man is available as back-up in case the first suddenly becomes ill. The backup man will be voice communicator at the Cape.

The timetable for the 1424-mile MA-2 flight Feb. 21 was almost as rapid as that for the 235-mile MR-1 last Dec. 19. Liftoff at 9:10 a.m. was followed by acquisition of the signal by a downrange search plane at 9:21, impact at 9:28, visual sighting at 9:32, pickup by helicopter at 9:53 and delivery to the deck of the U.S.S. Donner at 10:06—56 minutes after liftoff.

The MA-2 capsule reached an altitude of 107 statute miles and maximum velocity of 12,850 mph before landing 1424 miles downrange, 410 miles east northeast of Roosevelt Roads, Puerto Rico. This compared with a nominal altitude of 115 miles and range of 1400 miles.

# —when and where—

## MARCH

**Optical Society of America,** Roosevelt Hotel, Pittsburgh, Mar. 2-4.

**Gas Turbine Conference and Exhibit, sponsored by Gas Turbine Power Division of American Society of Mechanical Engineers and U.S. Department of Defense,** Shoreham Hotel, Washington, D.C., Mar. 5-9.

**Eleventh Annual Instrument Society of America, Conference,** Roosevelt Hotel, Pittsburgh, Mar. 8-10.

**Second Symposium on Engineering Aspects of Magneto-Hydrodynamics, University of Pennsylvania, PGNS, AIEE, IAS,** University Museum, Philadelphia, Mar. 9-10.

**Institute of the Aeronautical Sciences, Flight Propulsion Meeting** (classified), Cleveland, Mar. 9-10.

**American Society of Mechanical Engineers, Aviation Conference,** Statler Hilton Hotel, Los Angeles, Mar. 12-16.

**American Rocket Society, Test Operations and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

**Inter-Station Supersonic Track Conference (confidential), Supersonic Track Symposium,** U.S. Naval Ordnance Test Station, China Lake, Calif., Mar. 14-16.

**Fifth National Conference on Aviation/Space Education,** Mayflower Hotel, Washington, D.C., Mar. 16-18.

**American Astronautical Society Symposium, Interactions of Space Vehicles with an Ionized Atmosphere, co-sponsored with AFOSR and ARPA,** Sheraton Park Hotel, Washington, D.C., Mar. 17.

**American Congress on Surveying and Mapping, and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 19-25.

**IRE International Convention,** Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 20-23.

**American Society for Metals, 12th Western Metal Exposition,** Pan-Pacific Auditorium, Los Angeles, Mar. 20-24.

**23rd Annual American Power Conference,** Sherman Hotel, Chicago, Mar. 21-23.

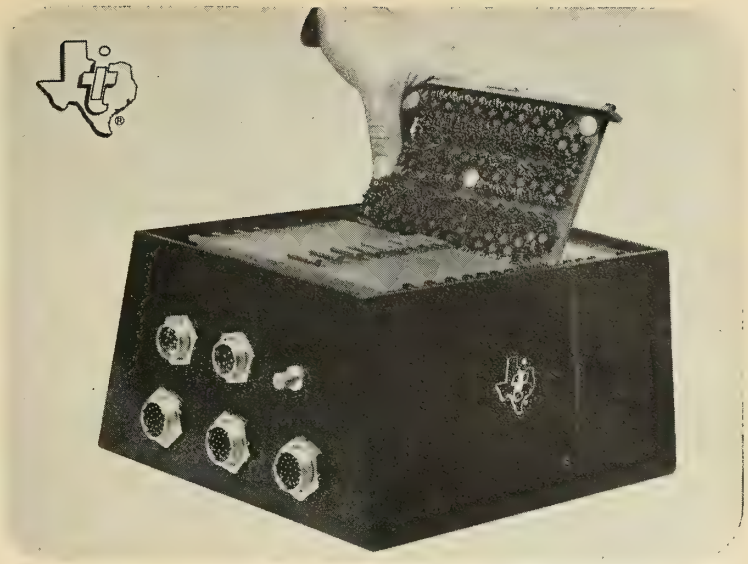
**American Meteorological Society, General Meeting,** Chicago, Mar. 21-23.

**American Chemical Society, 139th National Meeting,** St. Louis, Mar. 21-30.

**4th Symposium on Temperature, Its Measurement and Control in Science and Industry, sponsored by ISA, AIP, NBS,** Veteran's Memorial Hall and Deshler Hilton Hotel, Columbus, Ohio, Mar. 27-31.

**American Nuclear Society, Nucleonics in Flight Symposium,** Statler Hilton Hotel, Dallas, Mar. 28-29.

**Society of Aerospace Material and Process Engineers, Filament Winding Symposium,** Huntington-Sheraton Hotel, Pasadena, Calif., Mar. 28-30.

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# —reviews—

MACHINING CHARACTERISTICS OF HIGH STRENGTH THERMAL RESISTANT MATERIALS, Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J. 181 pp., $4.60.

A study of the machining characteristics in turning, milling, drilling and tapping has been conducted on 25 high-strength thermal-resistant alloys. Relationships are presented between tool life, cutting speed, feed, tool geometry, tool material and cutting fluids.

Increased requirements are described for precise control of rigidity speeds, feeds, tool geometry for machine tools to handle these alloys. Alloys studied were of the following classes: Martensitic low-alloy steels, hot work die steels, austenitic stainless, martensitic stainless, ph stainless, nickel-base and cobalt-base high-temperature alloys and titanium.

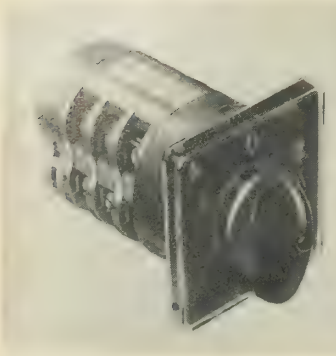
SPACEFLIGHT TECHNOLOGY, Proceedings of the first Commonwealth Spaceflight Symposium, edited by Kenneth W. Gatland, Academic Press, New York, 365 pp., $11.

Nearly two dozen of the top European spaceflight experts contributed to this Commonwealth conference, held in 1959. In several instances, the information given in the book is of purely local interest—such things as Commonwealth university participation, Canadian facilities and Britain's place in interplanetary exploration.

Generally, however, the papers presented will be of use to many engineers and scientists in the spaceflight field. Among the topics covered are launching vehicles and space vehicles' space vehicle cabins, propulsion system, instrumentation, tracking and communication, and the exploration of the moon. This last paper deals with the minimum propulsion needed for the soft moon-landing of instruments.

PROCEEDINGS OF MEETING ON PROBLEMS AND TECHNIQUES ASSOCIATED WITH THE DECONTAMINATION AND STERILIZATION OF SPACECRAFT—JUNE 29, 1960. Jack Posner, Editor. Appendix: Sterilization of Interplanetary Vehicles. Charles R. Phillips and Robert K. Hoffman. Order NASA Technical Note D-771 from National Aeronautics and Space Administration, Washington 25, D.C. 57 pp., $1.50.

A meeting was held by representatives of agencies concerned with the development of space vehicles and those investigating decontamination and sterilization procedures. The conferees recommended that: (1) a body of related information be accumulated, (2) standard operating procedures be established, (3) acceptable limits of contamination be determined, (4) NASA policy be clarified, (5) new sterilizing agents be developed, (6) compatibility studies be pursued, (7) sterile manufacture of parts be investigated, and (8) a working level group be formed to implement recommendations and procedures.



## Versatile Rotary Switch

A 20-amp, 600 VAC modular design rotary switch is available from American Solenoid Co., Inc. Unit can be employed for motor control up to 16 HP at 600 volts, as well as for instrumentation and control circuits.

Designated as Type C-16, this switch contains two isolated double-break silver-alloy contacts in each stage. Twelve stages can be combined to form a single column of 24 contacts. Up to 4 columns arranged in tandem can be used in a switch assembly to control up to 96 double-break contacts over 18 positions, from a single control point.

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## Micron Particle Filter

Gelman Instrument Co. is producing a membrane filter, specifically designed to speed counting and sizing of contaminant particles in air, military fluids, and other liquids.

The membrane filter is a thin microporous plastic material with controlled micron size pores. The membrane filter is available in a dark green color. The color has been chosen so that almost all dirt particles are visible under the microscope. Both dark and light colored particles are clearly contrasted against the green color of the filter.

Circle No. 226 on Subscriber Service Card.

## Spectrometer Typewriter

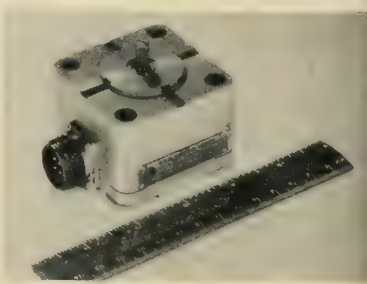
A typewriter read-out system for direct reading spectrometers is available from Jarrell-Ash Co.

In the Typewriter Print-Out System the spectrometric data is recorded automatically after the exposure is terminated. Carbon copies are readily made. Pre-printed or pre-typed forms may be used and complete analytical reports thus prepared. The typewriter prints a number proportional to percent concentration of the chemical elements present in the sample.

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## RPM Control Switch

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Expanding programs at the General Atomic Division of General Dynamics Corporation in San Diego, California, have created several responsible positions for experienced electronic engineers. These positions will involve the design and development of electromechanical devices, including instruments, motor controls, and servomechanisms.

A BSEE degree and at least three years of closely related experience will be required. Specific experience in connection with nuclear reactor programs is desirable but not mandatory.

**Please submit a resume to:**

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**P. O. Box 608, San Diego 12, Calif.**

**GENERAL DYNAMICS**
**GENERAL ATOMIC**
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Models are available with 1, 2 or 3 snap-action electrical switches, each set to actuate at a preset RPM. This permits governing of a sequence of operations which are functions of speed. The flyweight-centrifugal force principle is employed to control switch operation. Repeatability and differential can be held as low as 1% or less. Operating ranges between 700 and 5000 rpm or higher are obtainable.

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## Viscous Material Pump

The Robinson Machine Co. is producing a variable discharge metering pump. The pump will deliver accurately B. F. Goodrich's Plastisol, as well as other materials of similar nature, into a 2-5/8 in. cylindrical disc. Applications would include cementing, filling, potting, and sealing.

The device is a positive displacement gear pump whose discharge is controlled by an adjustable ratchet mechanism, a single revolution clutch and a constantly running motor.

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## Plug-in Transformers

A series of micro-miniature transformers with 0.030 in. diameter brass pin leads spaced .100 in. apart, to "plug in" to a standard 5 pin subminiature socket or to facilitate "soldering-in" for permanent installations, is available from James Electronics Inc. The ½ in. diameter metal cases are sealed and potted to meet MIL-T-27A, grade ". "U" Series impedance ranges are available from 10 ohms to 300 K ohms.

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## Flexible Pigtails

A series of stainless steel teflon flexible pigtails is available from The Bastian-Blessing Co. Made up of a resilient Teflon liner reinforced by a rugged stainless steel braid cover, RegO flexible pigtails are rated at 3000 psi working pressure.

These flexible pigtails have connections machined to CGA and other industry standard specifications for use with acetylene, helium, LP-gases, nitrogen, oxygen and a host of other gases or may be furnished with ¼ in. NPT female ends. All are carefully cleaned for oxygen service and individually pressure tested before shipping.

Circle No. 231 on Subscriber Service Card.

## Dust Toroidal Inductors

United Transformer Corp. is marketing eight "MQ" type permalloy dust toroids. These types provide the highest factor in their class with miniatured dimensions. All units are hermetically sealed, meet or exceed MIL-T-27A specifications and are laboratory adjusted to 1% tolerance. Hum pickup is extremely low due to the toroidal winding structure, with windings uniformly spread over the core.

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TI developed FM/FM transmitters and power supplies operated in "Ham" MERCURY spacecraft test. TI will supply FM/FM systems for later MERCURY shots.

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## Velocity Vibration Probe

Dynamic Devices is marketing a velocity type vibration probe with a moving weight of 0.1 grams. The probe has an output of 6mv/in/sec with a 40 ohm coil free to travel in excess of 3/16 in. double amplitude. This quick and easy-to-use probe has no cumbersome attachments, and is ready for immediate use by feeding the output directly to a high gain scope.

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## Miniature Check Valve

A miniature check valve with a total pressure drop of less than 1 psi at rated flows, is available from Spartan Manufacturing Corp. Identified as the Spartan 606, it has a maximum cracking pressure of 8" of $H_2O$ while total pressure drop does not exceed 20" of $H_2O$ at rated flow. The valve is compatible with 90% hydrogen peroxide, nitric acids and other fuels.

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## DC Operational Amplifier

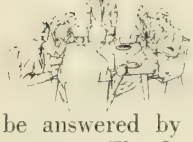
Micro Gee Products, Inc., is producing a low cost DC Operational Amplifier designed for rack mounting in a standard 19 in. wide rack. The Model 505A consumes 3½ in. of vertical rack space, is completely self-contained, operates directly from a 115 volt 60 cps line, and features response to 5 kc and an open loop gain of 5000. A chopper stabilized version, the Model 505AS, is also available.

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*Official National Aeronautics and Space Administration Photograph*

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# contracts

## NASA

**Western Scientific Instrument Company, Inc.**, Redwood City a Van Nuys, Calif., for calibrating, maintaining and repairi electronic instruments vital to research in space vehicles, aircr and the physiological response of human pilots. To be co ducted at Ames Research Center, Moffett Field. Amount i disclosed.

$400,000—**G. T. Schjeldahl Company**, Northfield, Minn., for desi development, fabrication and testing of rigidized inflata spheres for its passive communication satellite program, Proj *Echo*. Contract to be managed by Langley Research Cent Langley Field, Va. under direction of Goddard Space Flig Center, Greenbelt, Md.

$56,362—**University of Alabama**—(four contracts) for research develop methods for solving guidance and control proble peculiar to multi-stage space vehicles varying from high to l thrust; a study of transient fluid heat transfer problems; method for correlating temperature-fatigue data for metals a alloys; and theoretical study of the use of cesium in electrical propelled space vehicles.

$53,262—**University of Alabama**, for analytical research on theoretical physics of ion beam neutralization for electrical propelled space vehicles.

$46,900—**A.G.A. Corporation**, Alexandria, Va., for C-Band ra beacons.

## MISCELLANEOUS

$300,000—**Electronic Engineering Company of California**, Santa A Calif., for manufacture of electronic data processing equipme from **Sandia Corporation**, Albuquerque, N.M.

$161,637—**J. A. Tiberti Construction Co.**, Las Vegas, Nev., fr Atomic Energy Commission for construction of support facilit in the Rover Test Area of the Nevada Test Site.

## NAVY

$300,000—**Electronic Assistance Corp.**, Red Bank, N.J., for comma radio receivers and transmitters to control target drones, pil less aircraft and missiles.

## ARMY

**Maurice H. Connell & Associates, Inc. and Reynolds, Smith & Hi** Miami, Fla., for architect-engineer services for design of *Satu* Launch Complex 37 (NASA) Facilities, Cape Canaveral Miss Test Annex, Patrick AFB, Fla. Amount not disclosed.

$3,920,391—**Raytheon Co.**, Waltham, Mass., (two contracts) concurrent and replenishment repair parts for *Hawk* miss system.

$967,000—**Sperry-Rand Corp.**, Salt Lake City, for research and d velopment on the *Sergeant* missile system.

$583,740—**Western Electric Co., Inc.**, New York City, for producti engineering services for the preparation of Misc. Ord. Doc mentation for the *Nike-Hercules* guided missile system.

$494,041—**Cornell Aeronautical Laboratory, Inc.**, Buffalo, N.Y., high-power microwave radar research program.

$101,380—**General Electric Company**, Burlington, Vt., for producti engineering study of XM3 Timer for the XM84 adaption kit.

$64,793—**Douglas Aircraft Co.**, Santa Monica, Calif., for field chan kits and repair parts for *Nike/Ajax Hercules*.

$61,532—**Sperry Rand Corp.**, Salt Lake City, for repair parts *Sergeant* guided missile system.

$46,856—**Electromechanical Research Co., Inc.**, Brooklyn, N.Y., development and fabrication of low-drag, high-energy armo penetrating projectiles.

$45,901—**Dynametrics Corp.**, Burlington, Mass., for continuation contract for design and fabrication of data recording syste and associated equipment.

$32,234—**University of Alabama**, for theoretical study of t opaqueness of the atmosphere and its radiation temperature.

$31,402—**Gilfillan Bros., Inc.**, Los Angeles, for replenishment quirements for *Corporal* missile system.

## AIR FORCE

**Hughes Aircraft Company**, for *Titan* launch site activation wo Details not yet released.

$2,500,000—**Rocketdyne Division of North American Aviation, In** Canoga Park, Calif., for technical data in support of *WS 107A* propulsion subsystem and related GSE.

$2,162,067—**B. F. Goodrich Aviation Products**, Akron, Ohio, aircraft fuel cells and tires for the B-52 and miscellaneous Ne aircraft and electrothermal, anti-icing systems for the *Hou Dog* missile.

$151,988—**Boeing Airplane Co., Aero-Space Division**, Seattle, reproducible copy and negatives applicable to *IM99A* and *IM9* missiles, and TCTO, engineering and retrofit kits for *IM9* missile, (3 contracts).

$200,797—**A. W. Hayden Co., Div. of Consolidated Electronics I dustries Corp.**, for stop timers, electrical type, electromagn operated.

$86,000—**Advanced Technology Laboratories**, Mountain View, Cal for prototype systems to measure temperatures at the surfa of *Dyna-Soar*'s skin panels and leading edges. Subcontract fr **Boeing Airplane Company.**

$31,860—**McCulloch Corp.**, Los Angeles, controls to support tar drones.

# ADVERTISERS' INDEX


Aerojet-General Corp., Sub.-General Tire & Rubber Co. ..... 12
Agency—D'Arcy Adv. Co.

Aerospace Corp. ..... 6
Agency—Gaynor & Ducas, Inc.

Air Products, Inc. ..... 74
Agency—Diener & Dorskind, Inc.

AiResearch Mfg. Co., Div.—The Garrett Corp. ..... 67
Agency—J. Walter Thompson Co.

R. C. Allen, Aircraft Instrument Div. 56
Agency—Jepson-Murray Adv., Inc.

American Cystoscope Makers, Inc. .. 68
Agency—Sproul & Assoc., Inc.

American Time Products, Inc. ..... 93
Agency—H. M. Alexander & Assoc., Adv. Agency

Avco Corp. ..... 55
Agency—Benton & Bowles, Inc.

Bell Aerosystems Co., a Div. of Bell Aerospace Corp. ..... 2
Agency—The Rumrill Co., Inc.

Bendix Corp., The, Scintilla Div. .... 78
Agency—MacManus, John & Adams, Inc.

Bristol Co., The, Aircraft Equipment Div. ..... 75
Agency—Chirurg & Cairns, Inc.

Callery Chemical Co. ..... 58
Agency—Ketchum, MacLeod & Grove, Inc.

Convair/Fort Worth, a Div. of General Dynamics ..... 52
Agency—Glenn Adv., Inc.

Curtiss-Wright Corp. ..... 69
Agency—Buchen Adv., Inc.

Delco Radio, Div.—General Motors Corp. ..... 10
Agency—Campbell-Ewald Co.

G. C. Dewey Corp., The ..... 90
Agency—George T. Petsche Adv.

Douglas Aircraft Co., Inc. ..... 14
Agency—J. Walter Thompson Co.

Edgerton, Germeshausen & Grier, Inc. 38
Agency—Reach, McClinton & Humphrey, Inc.

Englehard Industries, Inc. ..... 82
Agency—Stuart Sande, Adv.

Carl Fisher & Co., Inc. ..... 52

General Electric Co., Light Military Electronics Dept. ... 43

General Electric Co., Silicone Products Dept. ..... 3
Agency—Ross Roy-B.S.F.&D., Inc.

Grumman Aircraft Engineering Corp. 60
Agency—Fuller & Smith & Ross, Inc.

A. W. Haydon Co., The ..... 71
Agency—Hicks & Greist, Inc.

Huyck Systems Co. .....48, 49

Interelectronics Corp. ..... 65
Agency—Meyer & Behar Adv., Inc.

Kollmorgen Corp. ..... 86
Agency—Wilson, Haight & Welch, Inc.

Lincoln Laboratory—Massachusetts Institute of Technology ..... 66
Agency—Randolph Assoc., Adv.

Litton Industries, Litton Systems, Inc. 63
Agency—Compton Adv., Inc.

Lockheed Aircraft Corp., Missiles & Space Div. ..... 76
Agency—Hal Stebbins, Inc.

Magnetic Controls Co. ..... 8
Agency—Scrymiger & Osterholt, Adv., Inc.

Metal Bellows Corp. ..... 72
Agency—George T. Metcalf Co.

Microdot, Inc. ..... 47
Agency—Carson/Roberts/Inc.

Missile Component Cleaning Labs .. 88
Agency—Philip Klein Adv., Inc.

National Aeronautics & Space Administration .....11, 84
Agency—S. G. Stackig, Inc., Adv.

New Departure Div.—General Motors Corp. ..... 9
Agency—D. P. Brother & Co.

Pan American World Airways, Inc., Guided Missiles Range Div. ..... 59
Agency—Willard E. Botts Adv., Inc.

Philco, Techrep Div. ..... 70
Agency—B. K. Davis & Bro., Adv. Service

Philco, Government & Industrial Div. . 50
Agency—Maxwell Assoc., Inc.

Powertron Ultrasonics Corp. ..... 61
Agency—Donaldson Assoc., Inc.

Radio Corp. of America, Service Co. 54
Agency—Al Paul Lefton Co., Inc.

Reinforced Plastics, Dept. of Raybestos Manhattan, Inc. ..... 91
Agency—Gray & Rogers, Adv.

Remington Rand UNIVAC, Div.—Sperry Rand Corp. ..... 62
Agency—Mullen & Assoc., Inc.

Space & Information Systems Div. of North American Aviation, Inc. ... 7
Agency—Batten, Barton, Durstine & Osborn, Inc.

Space Technology Labs., Inc., sub. of Thompson Ramo Wooldridge Corp. 73
Agency—Gaynor & Ducas, Inc.

Sperry Farragut Co., Div.—Sperry Rand Corp. ..... 64
Agency—Chirurg & Cairns, Inc.

Sperry Phoenix Co. ..... 4
Agency—Reach, McClinton & Co., Inc.

Stillman Rubber Co. ..... 53
Agency—McNaughton-Laub, Inc.

Technic, Inc. ..... 79
Agency—Lanning Assoc., Adv.

Texas Instruments, Inc. ....83, 85, 87, 89
Agency—Don L. Baxter, Inc.

Vitro Electronics, a Div. of Vitro Corp. of America ..... 57
Agency—Sam J. Gallay Adv.

Washington Technological Assoc. ... 94
Agency—Dawson, MacLeod & Stivers

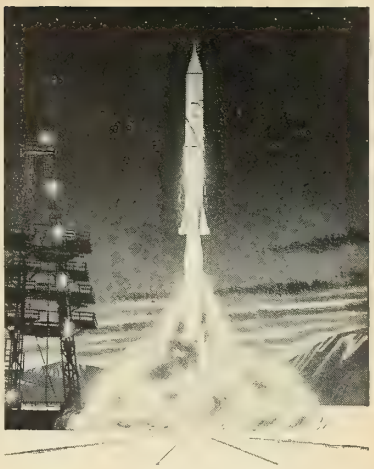
Willson Products Div., Ray-O-Vac Co. .....35, 36
Agency—Howard H. Monk & Assoc., Inc.


## EMPLOYMENT


Air Products, Inc. ..... 82
Agency—Diener & Dorskind, Inc.

General Atomic Div. of General Dynamics ..... 88
Agency—Barnes Chase/Adv.





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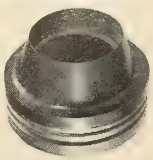
## hottest weight-savers for hot missile parts

Pound for pound, R/M asbestos-phenolic missile parts give you far greater strength and stability at extreme temperatures than metals.

This amazing family of asbestos reinforced plastics retain their good mechanical properties for the time-temperature relationship required for missile parts. At elevated temperatures where other materials fail, R/M asbestos-phenolics provide superior strength retention and controlled ablation.

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## editorial . . .

# The Girl with the Soldering Iron

WE ARE ALL getting a little tired of the word reliability—but it is probably the most important single word today in the electronics branch of the missile/space industry.

The success of all our missile/space systems depends in large measure on how good a job has been done on the electronics. Here, if anywhere, the traditional twenty-five-cent part can mean crushing defeat for a team that has been working long months toward an important launch. The same is true of the less traditional $250,000 part.

Nowhere is reliability more important than in the field of guidance and control, to which this annual electronics issue is devoted. You will find the word in almost every article. The industry's big problem is to combine the highest reliability of a complex part with the lowest cost.

The firms accomplishing this successfully still will be with us when the guidance and control market passes that $1.5-billion mark. Those failing to meet both standards will find they have been replaced as leaders by hungry, eager and accomplished production teams now close on their heels.

Sheer size is no guarantee of continued success. The missile/space industry is one in which the worth of the electronic design engineer, production engineer, assembly line worker and quality control staff is quickly and openly tested right on the launch pad or in the unforgiving depths of space.

Shoddy work by someone on the transistor production line of General Electric is evident just as fast as shoddy work in a small firm. A few failures can build a bad reputation for a major firm as swiftly as for its smaller competitors, thereby reversing their market standing.

The important part is the one being worked on right now.

The best management team in the world can't make it work. The girl with the soldering iron in her hand can.

We hear frequently that the electronics part of our industry is in a state of flux. So it is, but this is usually said in a manner which indicates we are in a "transition period" which will soon end, meaning just as soon as we get those bums down the street out of business.

We doubt if the day will ever come when missile/space electronics is not in a state of flux. This is a young, vigorous, flexible industry capable of meeting the rapidly-changing requirements of missilery and space exploration.

But if reliability falls off or costs creep up, your firm may next week be begging subcontracts from that bum down the street.

There is another penalty, too, for the firms and individuals participating in this branch of our industry. A considerable amount of money must be poured into research and development. In the guidance field, for example, R&D will take up well over 25% of the money spent this year.

Inertial is coming up; radio command is declining. What do you put your money on? Does optical look better than infrared? Which company should you go to work for? What type of radar looks most promising? No wonder your wife says you look bad lately.

There are other pitfalls to be avoided. One danger in an industry as young as ours is the tendency to follow new trends, perhaps at the risk of both company and national security. For example, there are strong arguments for all-inertial guidance systems. But let's not write off radio command without a good long look at its advantages. Maybe some of that R&D money should be spent exploring them. Let's not jump on the all-inertial bandwagon just because it seems the thing to do at the moment.

IN RETURN FOR these large expenditures of money and brains in missile/space electronics, there are big rewards. The guidance and control market alone is worth nearly $1-billion this year. And that's only a part of the total electronics expenditure in the missile/space field, which is growing faster than the general electronics market.

But perhaps the biggest reward is the chance to participate in the most exciting and nationally important field open today to an individual or firm, young or old: the exploration of space.

You will, however, have to learn to live with the word reliability. No matter how tired of it you get, it's with us to stay and you'll hear it on Mars.

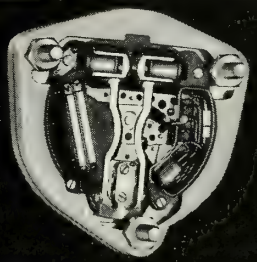
If that girl with the soldering iron doesn't put you out of business before then.

**William J. Coughlin**

# FREQ. STDS.

## AND TUNING FORK OSCILLATORS

TYPE 10, ACTUAL SIZE



SIZE, 1-3/8" x 1-3/8" x 3/8"

**This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.**



TYPE 2007



TYPE 15

For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

### TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

### TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

### TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2 5/16"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

### TYPE 15 FREQUENCY STANDARD

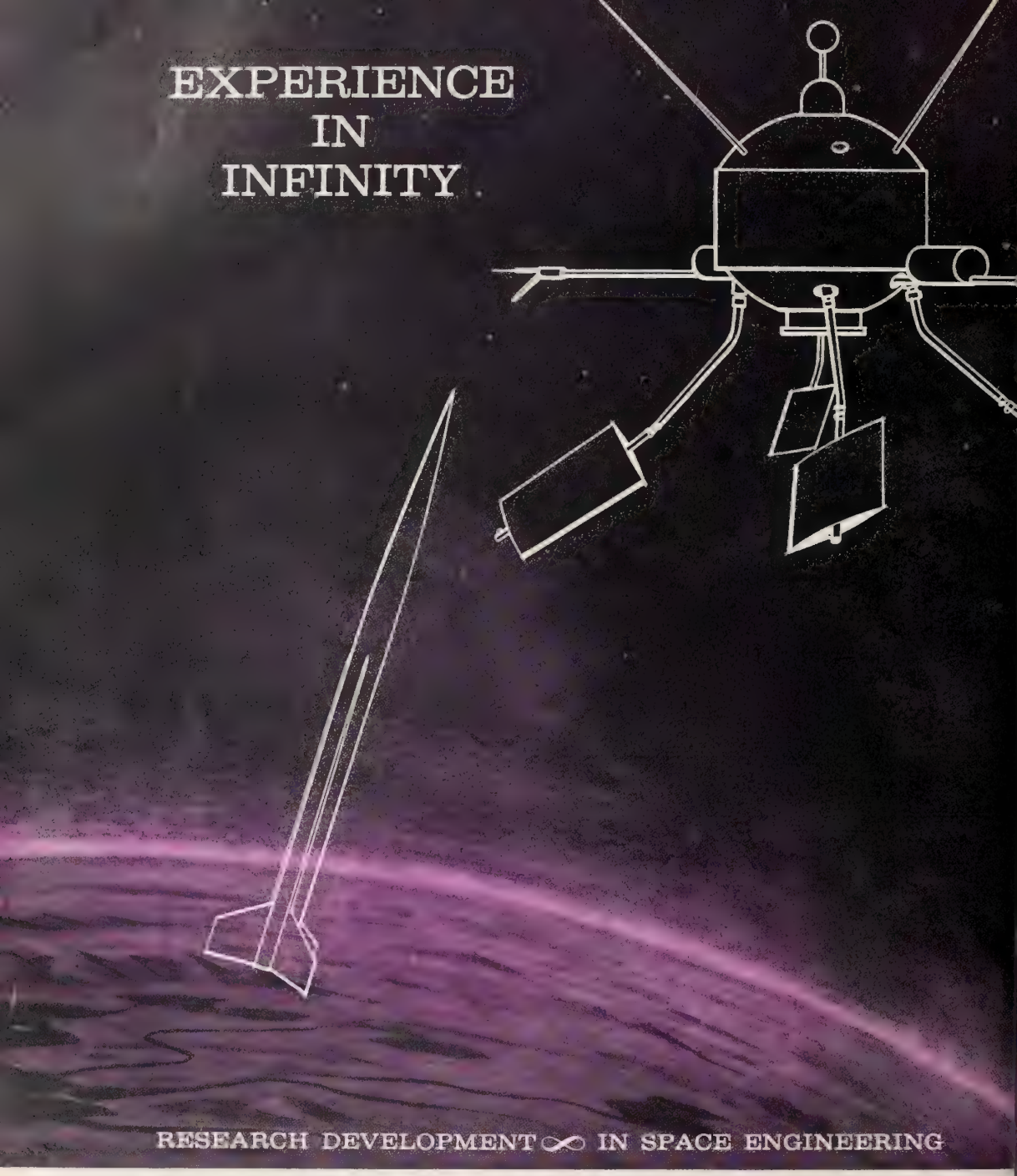
Similar to Type 10 (illustrated) except with silicon transistor, hermetically sealed and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from —40°C to + 71°C
Output: .IV at 50,000 ohms source impedance.

ATP INC.

**AMERICAN TIME PRODUCTS, INC.**

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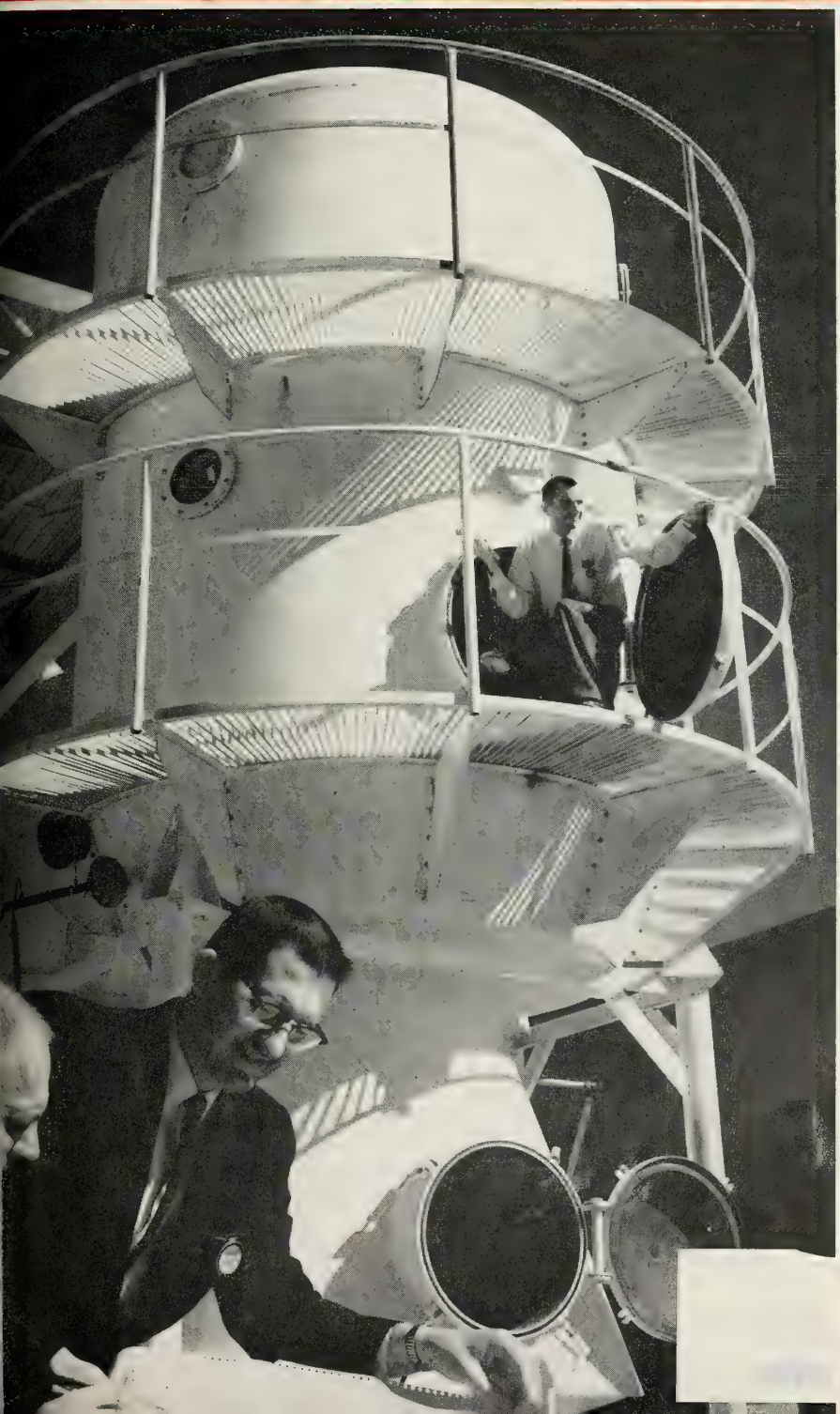
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MARCH 6, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

MAR 196
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## Dyna-Soar Will Get Solid-fuel 3rd Stage

- JFK Weighs 'Shift' in Arms
- Cleaners Bare Missile Flaws
- New Edition—M/R Astrolog

*Convair's Three-Man Space Station Model*

AN AMERICAN AVIATION PUBLICATION

Monsanto

Space-Age Project "ELECTRON"

# A CHEMICAL EXPEDITIO



# .ranging the fields of ultra-pure metals and "intermetallics"...finds new chemical routes to materials for advanced electronics

*Monsanto research in the chemistry of silicon, phosphorus, ultra-fine metals and oxides, and "superpure" elements and compounds has found promising leads to improve semiconductors. These materials—developed by the synergistic collaboration of solid-state physicists, inorganic chemists, and physical chemists—forecast improved performance of transistors, photoconductors, thermoelectric generators and coolers, solar batteries, rectifiers, thermistors and other electronic applications that depend upon the tractability and mobility of electrons moving through special composition solids.*

Monsanto researchers, from a firm base in the commercial production of semiconductor silicon (under Siemens-Westinghouse license), have found a number of intriguing leads to new and improved semiconductor materials suitable for transistors, rectifiers, diodes, thermoelectric coolers and generators, and Hall-effect devices.

Since the middle 50's—the burgeoning uses of transistors, diodes, rectifiers, as well as thermoelectric, photoelectric, and servo devices, have kept chemists on a logged search for substances with a given quantum of mobile electrons that would behave predictably. To the "armchair chemist" the semiconductor problem might look deceptively simple: check out a relatively few elements and compounds, purify them highly, dope them in the order of 1:10,000,000 with an element from another periodic group to provide the proper *n* or *p type* conductance; and grow into crystals.

A minimum of experimentation, however, would quickly establish that the chemistry of preparing the super-pure materials and uniformly doping them to produce n-type and p-type semiconductors is one of the most intricate problems that inorganic and physical chemists have ever tried to solve. Not the least of the problem is that no reliable method has been developed to predict the energy gap; all possible combinations and proportions of candidate elements have to be prepared and the energy gap determined empirically!

In attacking this whole problem of semiconductor materials for advanced electronics, Monsanto research is focused on the following four areas of study:

**1. PURITY IMPROVEMENT...**
of "III-V" semiconductor compounds by at least one or two orders of magnitude over best purity yet available; and, concomitantly, studies of new techniques for converting these high-purity compounds into single crystals. When completed, a variety of new and improved electronic devices can be developed with these high-purity materials.

**2. "SPOT" SYNTHESIS AND SCREENING...**
of candidates in numerous classes of compounds for organic semiconductors—compounds where structural concepts point to the compounds' ability to shift electrons. (In organic semiconductors, too, uniformity and purity are vitally important.)

**3. NOVEL CHEMICAL PROCESSES...**
are under intense study for the preparation of compounds of group "II-VI" type semiconductors.

**4. NEW INORGANIC SEMICONDUCTORS...**
i.e. gallium and indium arsenides are now available for research and development. Doping of gallium arsenide is in progress.

A major purpose of this semiconductor chemistry research is to find materials with greater reliability over a wider temperature range, the ability to function at high temperatures, and variously with improved electrical, photoelectric, thermoelectric, magnetic, and photoconductance properties. By intensifying—chemically—the electronic property sought, improved devices based on these properties will become feasible. In collaboration with electronics manufacturers, the materials now on the horizon will serve in telemetry, automation monitoring devices, guidance computers, ignition systems, and communications equipment. These materials will also open the door more widely for increasing the efficiency of thermoelectric power generation, thermocooling devices, and photoelectric power generation. Promising leads are under study in "III-V" semiconductors of indium, gallium, and boron phosphides;* in new "II-VI" compounds and others.

*(Please turn page.)*

**F. V. Williams and R. A. Ruehrwein, J. Am. Chem. Soc., 82, 1330-2 (1960); D. E. Hill and B. D. Stone, Physical Review Letters, 4, 282 (1960).*

## THE BROADENING SPAN OF CHEMISTRY FOR ELECTRONICS

Monsanto researchers have already produced a variety of unique materials chemically tailored for the particular needs of electronic engineers. These materials range from liquid dielectric coolants for "packaged" units to singularly pure, reliable-performance large crystals of meticulously doped silicon. Many more, however, like the following, are in various stages of development:

**"III-V" INTERMETALLICS . . .**
prepared by Monsanto Research include polycrystalline indium arsenide (now used in Hall-effect devices such as watt-meters) and both single-crystal and polycrystalline gallium arsenide for tunnel, parametric, switching, and Zener diodes.

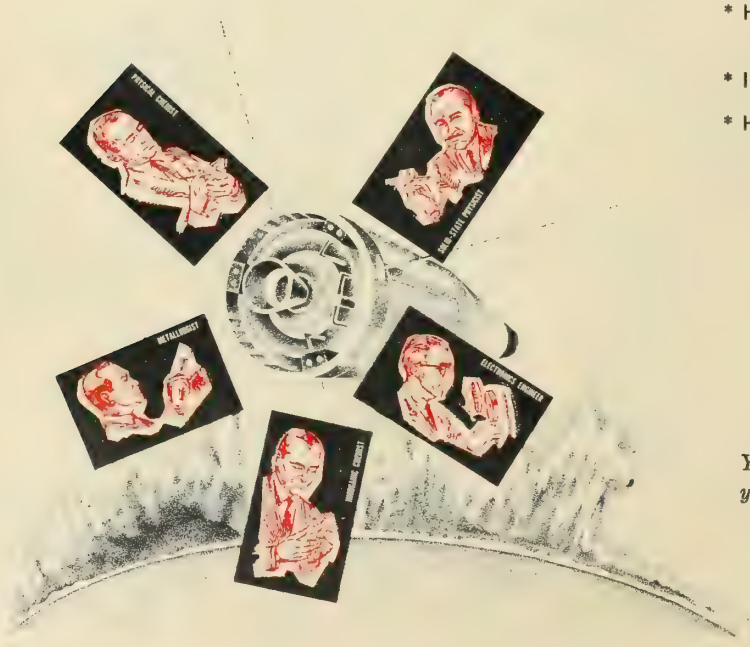
**DISPERSION-STRENGTHENED NICKEL AND COPPER METAL AND METAL POWDERS . . .**
are under study for corrosion-resistant electrodes, electrical contacts, and as high-strength, high-temperature core leads for electronic tubes and apparatus.

**HIGH-STRENGTH CERAMIC ENVELOPES . . .**
for vacuum tubes using specially developed fine mixed metallic oxides.

## SEMICONDUCTORS AND SPECIAL COMPOUNDS FOR ELECTRONICS . . .

**another chemical capability of Monsanto.**

If your work requires special semiconductor materials; ultra-finely divided metallic oxides; electronic coolants; high-temperature potting compounds; or high-strength, heat-resistant conductors—you are invited to take advantage of Monsanto's explorations and experience in these fields. Write or call: Monsanto Chemical Company, Department MR-2, C Building, St. Louis 66, Missouri.




## Monsanto Space-Age Projects for Government and Industry

* High-Temperature Hydraulic Fluids
* Coolant-Dielectrics for Electronic Equipment
* High-Temperature Plastics
* Improved Nitrogen Oxidizers for Solid Propellants
* Fire-Resistant Structural Plastics
* Hydrocarbon Fuels for Jets and Missiles
* Fire-Resistant Hydraulic Fluids for Ground-Support and Missile-Launching Equipment
* Radiation-Resistant Heat-Transfer Fluids
* High-Temperature Lubricants and Additives
* Radiation-Resistant Reactor Coolant-Moderators
* Intermetallic Semiconductor Materials
* Pure Silicon for Transistors, Rectifiers, Diodes
* Ultra-Fine Metal Oxides
* Materials for Vibration Damping
* Heat-Resistant Resins for Laminating and Bonding
* Inorganic Polymers
* High-Energy Solid Propellants

Monsanto

*You are invited to work with Monsanto on your materials needs in the above fields.*



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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 10 March 6, 1961

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## THE COVER

*Convair's MARS (Manned Astronautical Research Station) is full-scale working model of three-man space station. William Kudenov (left) is project leader; Freeman D'Vincent (center) designed the station.*

## MARCH 6 HEADLINES

Dyna-Soar to Get Solid-fueled Third Stage ..... 12
Booster Breakthrough May be Here—In Big Solids .. 13
McNamara Reported Urging 'Finite Deterrence' .... 14
Theodore Roosevelt Joins Polaris Sub Fleet ..... 16
Rep. Flood Sends M/R Zeus Report to Kennedy .... 18
Hughes Develops Optical Radar for Outer Space .. 18

## SPECIAL SECTION

Latest Edition of M/R Astrolog—A Status Report on All U.S. Missiles, Rockets and Space Vehicles, and All Satellites Now in Orbit ..... 23

## PROPULSION ENGINEERING*

Aerojet Develops Cooled Nozzles for Future ..... 31

## ADVANCED MATERIALS†

Dow Cleaning Bares Flaws in 'Combat-ready' ICBM's 32

## SPACE SYSTEMS

Surveyor to Collect Wide Range of Information .... 33

## ASTRONAUTICS

Lear Studies How Pilot May Best Control Attitude .. 36

## ASW ENGINEERING

AEC Funding Cut Hits SNAP 4 Undersea Power Unit 40

## INTERNATIONAL

NATO Interest Spurs French Sahara Range Extension 42

## DEPARTMENTS

The Countdown ..... 9
The Missile/Space Week† ..... 11
Technical Countdown . 21
Reviews ..... 44
Names in the News .. 45
Products & Processes.. 46
Contracts ..... 48
Letters ..... 48
When and Where ... 49
Editorial ..... 50

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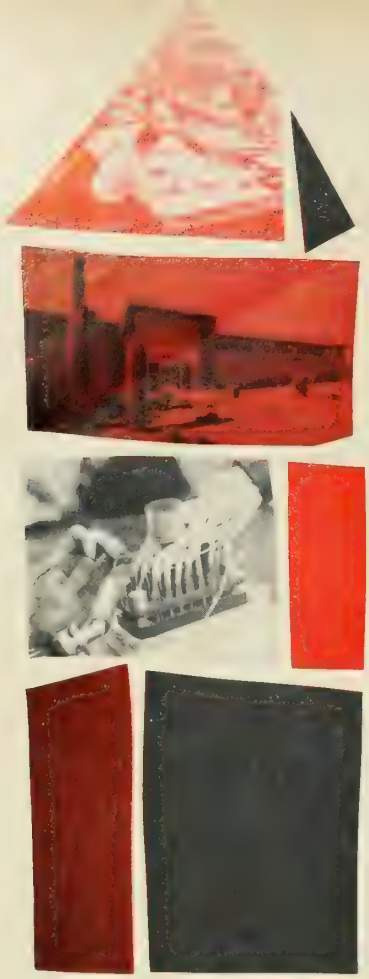
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# The Countdown

## WASHINGTON

### Morticians Measure ANP

Hopes for obtaining a nuclear-powered, missile-packing bomber are now all but dead. Top officials are conceding the ANP (air nuclear power) program appears to be leading nowhere, although about $1 billion has been spent on R&D. Says one: "You might say ANP is barely twitching."

### Military Space R&D Still 'Safe'

Continued high spending on military space R&D appears not to be in jeopardy in the "New Look" defense posture being weighed by the Kennedy Administration (see p. 14). The Air Force feels there will be heavy emphasis on offensive and defensive space systems, even though it has failed so far to sell the Administration on the merits of building a strategic missile counter-force.

### More Megatonnage?

Hot military issue underlying the East-West nuclear test ban talks that are to resume shortly is whether the United States will be permitted to increase the yield of *Polaris* and *Minuteman* warheads. Physicists believe megatonnage can be more than doubled, but not without more testing. This would be done underground to eliminate fallout—as the Soviets are suspected of doing already.

### Status of Soviet Air Defense

Highly authoritative U.S. sources have told Congress that the Soviets appear to be on a par with the United States in the development of rocket air defenses. The Russians are reported to be deploying their second-generation surface-to-air missiles, as is the United States. The second generation *Nike-Hercules* is capable of destroying Mach 3 targets at 100,000 feet.

### New Hunter-Killer Aircraft?

Some Air Force strategists are pushing for development of new hunter-killer aircraft for use against Soviet missiles in successive strikes in a nuclear war. The planes might carry up to 40 missiles with 1-kiloton warheads.

### NASA Reveals Pricetags

Cost of three NASA space vehicles is now put at: *Scout*—$17 million (for development and first nine vehicles), $935,000 per operational launch; *Centaur*—$170-180 million (for development and first 10 vehicles), $7.5 million per operational launch; *Saturn C-1*—$1 billion (for development and first 10 vehicles), $20 million per operational launch.

### Echo's Progress

Program for follow-on *Echo* passive communications satellites includes: *Echo II*—to be launched into an 800-mile polar orbit in 1962; the launching of three rebound spheres to a 17,000-mile orbit in late 1962, and simultaneous orbiting of six satellites a year later with a *Centaur* vehicle.

## INDUSTRY

### Defense Budget Reform Coming

A broad reform in defense budgeting procedures is under study in the Pentagon. Its aim: To provide top military planners with precise and comprehensive estimates of the total cost of major weapons and programs. This will mean that the fiscal managers of weapons projects will have to come up with the needed data.

### Nose Cone Stretchout Hits GE-MSVD

Payroll cutting is underway at GE's Missile and Space Vehicle Department because of stretchouts in the *Sky Bolt* and *Titan* Mark VI nose cone programs. Company officials estimate some 600 employees—about 8% of the department—must be transferred to other divisions or laid off.

### Naish Splits from GD

"Policy differences" with the management in New York are said to have led to the resignation of J. V. Naish as president of Convair, a post he had held since 1958. Naish also was a senior vice president of General Dynamics. Named acting president of Convair was C. Rhoades MacBride, who is also GD executive vice president.

### Douglas-Nesco Sign Research Pact

The National Engineering Science Co. of Pasadena, Calif., will perform advanced scientific research for Douglas Aircraft under a new agreement between the two firms. Work will supplement Douglas advanced research programs. Douglas will provide Nesco with engineering and production support facilities.

### Prospector Contracts Due Soon

NASA is understood to be prepairing to let study contracts in the near future for its *Prospector* mooncraft. The *Prospector* will be designed to land on the moon and roam its dusty surface by remote control. Time for take-off: 1965-1970.

## INTERNATIONAL

### Britain's Defense Budget

The British defense budget for FY '62 allots $1.5 billion to the Royal Air Force, $1.4 billion to the Army and $1.2 billion to the Royal Navy. Major missile armament continues to be the *Blue Steel, Honest John, Thunderbird* and *Seaslug*. ASW is to be beefed up with a new helicopter-dropped torpedo.

### New Space Combine

France's SEREB and Britain's Hawker-Siddeley group are planning to move quickly into the commercial communications satellite field. The new combine is reported aiming to get a workable system in orbit by 1965, perhaps sooner, to compete with U.S. companies.

### Sputnik VII Dies

The 7-ton *Sputnik VII* launched Feb. 4 burned up in the atmosphere on Feb. 26. One portion of *Sputnik VIII* which launched the Russian Venus probe Feb. 12, decayed on Feb. 25. NASA's Goddard Space Flight Center reports that fragments from both *Sputniks* are still in orbit.



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# The Missile/Space Week

## Minuteman Site Award

The Army Corps of Engineers has awarded a $61,773,644 fixed-price incentive-type contract to the joint venture of George A. Fuller Co. and Del E. Webb Construction Co. for 150 operational *Minuteman* facilities at Malmstrom AFB, Mont.

The contract was delayed for some time because the first group of bids received ranged from 50 to 100% higher than the Army's original estimate of $50 million.

The bids were knocked out and the Army added $12 million to estimates for contractor contingencies such as remote sites, terrain, and road conditions.

Brig. Gen. A. C. Welling, Commanding General of the Corps of Engineers Ballistic Missile Construction Office, said work will start by mid-March and is to be completed in 20 months. Date of the contract for the second *Minuteman* Site at Ellsworth AFB has not been disclosed.

## NASA Spurs Rover

NASA is reviewing its nuclear propulsion program so it can "proceed as rapidly as the technology will allow."

Deputy Administrator Hugh L. Dryden told the House Space Committee last week, "We are evaluating the needs of the program to insure that all necessary resources are provided."

The decision will mean increased funding for Project *Rover* in FY 1962. It also may result in a reversal of former Administrator T. Keith Glennan's stretchout of the *Rover* flight program. With his resignation last December, Glennan announced a delay of the target date for the first flight from 1965 to the 1966-7 period.

The Air Force is also maintaining its interest in exploiting the nuclear rocket for military application as an upper stage, as an inspace propulsion device and possibly as a single-stage launch system. ARDC has contracted a $400,000 nuclear rocket study.

## S-45 Waits in Wings

A backup *Juno II* vehicle is available for another attempt at launching an *S-45* ionosphere beacon satellite, but no decision will be made until after the *S-15* is launched, probably this month.

Just two vehicles now remain in the *Juno II* program. If the *S-15* cosmic ray satellite launching succeeds, the second will be used for a new try with *S-45*. If that fails, a decision will have to be made between the two for the last vehicle.

The first *S-45* was launched Feb. 24. NASA said all available evidence showed it did not achieve orbit. A malfunction shortly after booster separation was followed by loss of radio transmission. No tracking station acquired data that would indicate orbit.

## Advanced Polaris Scores

First sea launching of the advanced *Polaris* missile showed promising results in the Navy's program to bring the one-ton heavier model to combat readiness late this year.

Carrying only a rudimentary steering system for the test, the *A2* flew its entire range of 1500 nautical miles. The improved *Polaris* employs a more powerful solid fuel and has a greater fuel capacity than those now on station. Its 30-foot length is two feet longer than the operational model.

The *A2* has already scored three successes in four firings from stable pads at Cape Canaveral.

## First Atlas E Success

The *Atlas E* finally got started on its test program with last week's successful launch—the first success in four tries.

The *E*—first series with inertial guidance—will be the operational model for "coffin" launch sites.

After three failures, trouble was finally traced to a hydraulic control system. Improvement of the basic system—which had operated successfully throughout the program—apparently introduced some new bugs of its own.

The *Atlas F* now in the works is a streamlined version of *E* without instrumentation, for silo launch. Convair has also proposed a *G* version to the Air Force. This would be a radically different *Atlas* with improvements roughly comparable to those between *Titan I* and *Titan II*.


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**8900 De Soto Avenue,**
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*Award next month . . . .*

# Dyna-Soar to Get Solid Third Stage

***Boeing to order some 100 units similar to second stage of Minuteman; glass seen likely choice for lightweight case material***

Los Angeles—A solid-fueled third stage will be added to the *Titan II* booster for *Dyna-Soar.*

Missiles and Rockets has learned that Boeing Airplane Co. will award a contract next month for the new stage—described as a "foreshortened *Minuteman* second stage" able to generate about 60,000 lbs. thrust. The stage will be used to kick the *Dyna-Soar* glider to orbital velocity.

Approximately 100 cases are understood to be involved in the overall contract. Among the bidders are Aerojet-General Corp., Thiokol Chemical Corp., Grand Central Rocket Co., Hercules Powder Co., and the Rocketdyne Division of North Amerian Aviation Inc.

The disclosure came as:

–Lt. Gen. Bernard A. Schriever was reported ready to ask for a $100-million increase in FY '62 funding for *Dyna-Soar* to bring the total to $170 million. It would be used to chop 19 months from the development program and launch the first manned flight of the system by mid-1963.

–The Air Force said the first flight test of the glider aboard a *Titan II* (see artist's conception at right) would take place "within a year."

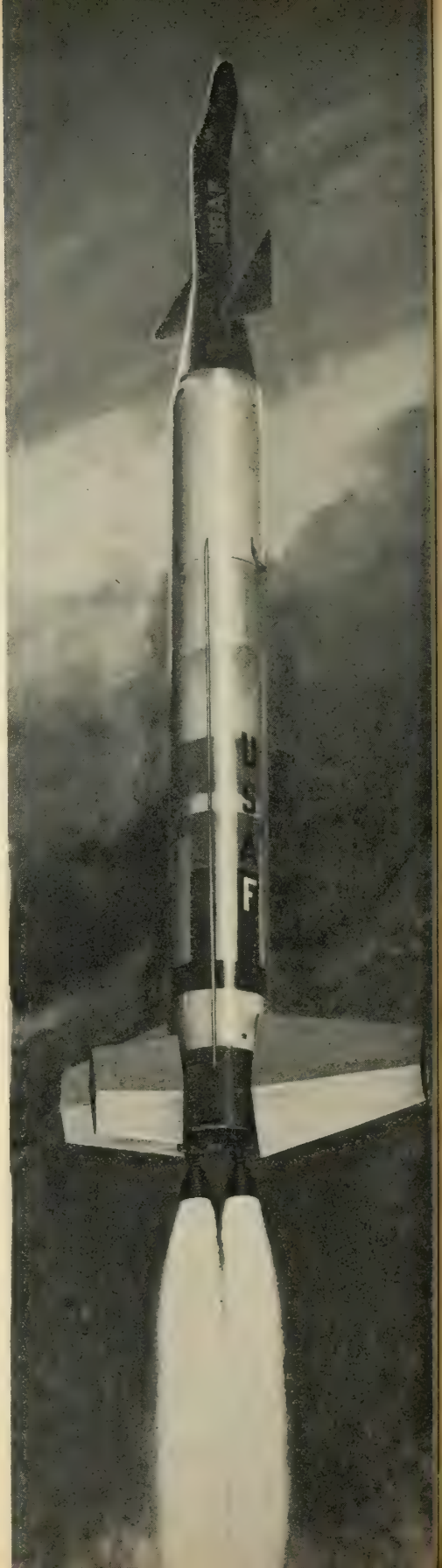
There was some thought that the switch from *Titan I* to *Titan II* (M/R, Jan. 30, p. 11) would eliminate the requirement for a solid third stage. Even if this does prove to be true, it is understood the unit will be retained anyway for use as an escape system similar to that on NASA's *Mercury* capsule. Hence nozzles will be designed for optimum operation at sea level—rather than at altitude.

Nozzles will be movable plus or minus ten degrees in one axis, but it has not been determined whether North American's Autonetics nozzle control unit will be used, as it is on *Minuteman.* The main requirement is that the motor be the lightest solid rocket possible.

Boeing is choosing light weight over optimum theoretical performance for the subsystem, with extreme emphasis on reliability—particularly for the escape application.

The escape mode would permit the pilot to trigger the

*(Continued on Page 43)*



# Big Solids—Booster Breakthrough?

## *Solids specialists argue that segmenting is answer to gap—and will save funds*

**by Jay Holmes**

*"Unless we are able to make a scientific breakthrough, we have to realize that we are in a . . . secondary position on boosters. . . . The Soviet Union has been ahead, and it is going to be a major task to surpass them."—John F. Kennedy, Feb. 15, 1961.*

MANY EXPERTS in government and industry are convinced that a big booster breakthrough already has taken place—all that is needed is a relatively modest sum of money to exploit it.

This "overlooked" breakthrough is in solid propulsion—a field in which the United States is believed far ahead of Russia and the rest of the world.

The breakthrough took place as far as they are concerned in February, 1953, 4½ years before *Sputnik*, when a small group of engineers from the U.S. Army, General Electric Co. and Thiokol Chemical Corp. flew the world's first case-bonded solid rocket —*Hermes RVA-10*—to a height of 190,000 ft. It was based in part on earlier research by Jet Propulsion Laboratory and Aerojet-General Corp.

Since then, scientists familiar with solid propellants have always claimed the sky was the limit for range and size, with minimum cost and complexity. But solids have never overcome the early lead of Liquid Rocket development.

The record shows that every major solid-propulsion program has met its objectives, on about the schedule promised, and within a figure close to the promised cost.

Within the last few months, *Polaris* has gone on station, *Minuteman* has flown all three stages perfectly on its first flight test, *Scout* has orbited a satellite on its fourth flight, and *Nike-Zeus* has passed preliminary tests.

• **$60 million price tag**—Solids specialists believe the time is ripe now to begin developing a large solid rocket, with total impulse of about 180 million pound-seconds, which would have two functions:

–It would provide a backup for the liquid-propelled *Saturn*, a giant basket in which America has placed all its eggs for the booster race with Russia over the next four or five years.

–It would compete directly with the single-chamber, liquid-propelled F-1 for the right to provide the basic propulsion unit for the booster on the manned lunar mission.

The cost? Industry estimates vary, perhaps by the degree of "salesmanship," between $35 and $55 million to develop the engine over a period of roughly 30 months. Informed government officials are confident the cost could not exceed $60 million.

This figure compares with spending of $250 million this year alone for *Saturn*. It compares with more than $50 million spent to date on developing the F-1—with several years of work before development is complete.



*CROSS-SECTION of grain of giant solid rocket, proposed by Thiokol, providing about 15,000,000 lbs. of thrust.*

No one is suggesting that work on *Saturn* and F-1 be scrapped or curtailed. The solids people put their idea forward in the spirit that the Kennedy administration is receptive to proposals that America do more to assure that we catch up in boosters at the earliest possible moment.

The cost of beginning the program in Fiscal Year 1962 is estimated at $10 million. Carrying it to completion would probably require $20-25 million the following year and something less the year after.

*(Continued on Page 43)*

## *Experts Agree on Feasibility*

SCIENTISTS FROM INDUSTRY generally agree that a big solid rocket can be developed cheaply and in a short time. Some typical comments:

Dr. Harold W. Ritchey, president of the American Rocket Society and a vice president of Thiokol, has said it would be possible to fabricate a 3-million-lb.-thrust solid in less than three years. "If we were in a hurry," he added, "we could have it in 18 months."

Dr. Ernest R. Roberts, assistant manager of the Aerojet-General Solid Rocket Plant, says no more feasibility proofs are needed. "*Polaris* and *Minuteman* have proven it, and the large segmented rockets we have fired—400,000 lbs. thrust—have proven the concept completely."

John Crowley, vice president, Grand Central Rocket Co., says the solid rocket is America's best hope to catch Russia in the booster race. "Unless we open our eyes," he declared, "we are going to be caught again as in 1957 with *Sputnik I* and in 1961 with Venus rocket."

Dr. David Altman, vice president of United Technology Corp., says America should "increase the versatility of our total arsenal of boosters by embarking on solid rocket programs, which will give greater economy and reliability and eliminate the thrust limitation."

Dr. Lyman G. Bonner, director of development, Explosives Department, Hercules Powder Co., says the principle of segmenting units weighing up to 150,000 lbs. removes the transportation limitation on solid rocket size and "there seem to be no inherent limitations."

Bonner said it is not clear there is incentive to build big segmented rockets today, because *Saturn* is well along in development. He added:

"I am sure, starting from scratch, a very large solid rocket could be developed and at less than the development cost of a corresponding liquid unit. We are not starting from scratch, however, since the . . . liquid units are in being or in the late stages of development."

# McNamara Reported Favoring Army-Na

***Recommendations to Kennedy may speed missile deployment, add limited war forces; base 'mess' debated***

**by James Baar**

DEFENSE SECRETARY Robert McNamara's secret recommendations for strengthening the nation's military posture are understood to be generally based on the Army-Navy advocated strategy of "finite deterrence."

If accepted, McNamara's recommendations would mean:

–A speed-up in the deployment of big strategic missiles on land and sea, but not a large increase in the total number already planned under the Eisenhower Administration in its final months.

–A sizeable increase in the nation's limited war forces, particularly far more rapid modernization of the Army and possibly several more divisions.

McNamara sent his recommendations to the White House amid new calls from Congress for production of the *Nike-Zeus* anti-missile missile and sharp congressional criticism of the Air Force ICBM base construction program.

Rep. Harry R. Sheppard, chairman of the House Subcommittee on Military Construction Appropriations, bluntly called the considerably delayed base-building program "a mess." Previously secret testimony released by his subcommittee showed that base-building costs have exceeded original estimates by 50 to 100% in many cases.

In regard to *Zeus*, House Democratic Leader John W. McCormac personally took the floor to urge pro duction "at the earliest possible mo ment." He added: "It is ready fo initial production now."

"On the day the Army is able t emplace *Zeus* batteries in active, op erational defense against incoming in termediate and intercontinental ballisti missiles, this nation will again stand i a dominant position in the world," McCormack said.

The next day Rep. Daniel Floo (D-Pa.), an outspoken member of th House Defense Appropriations Subcom mittee, wrote a letter to Presiden Kennedy urging the immediate produc tion of *Zeus* (see page 18).

• **No such change**—Kennedy at news conference last Wednesday mad the first official disclosure of at leas

## How ICBM Bases Slip, and Spending Soars

**All dollar quantities are in millions.**

| | LOCATION | | ORIGINAL CWE | CURRENT CWE | FUNDS | NO. OF CON-TRACTS | MAJOR CON-TRACT NO. | CONTRACTOR | DATE OF AWARD | |
|---|---|---|---|---|---|---|---|---|---|---|
| ATLAS D | Vandenberg 65-1 | Lompoc, Cal. | $ 9.0 | $14.9 | $14.8 | 12 | 5280 | Frederickson-Kassler-Stolte Inc. | 4 Jun 57 | 1 Sep 5 |
| | Vandenberg 65-2 | Lompoc, Cal. | 8.0 | 10.5 | 10.6 | 12 | 6293 | Utah-Hardeman-Manhattan | 18 Jul 58 | 19 May 5 |
| | Offutt | Omaha, Nebr. | 24.0 | 31.3 | 28.6 | 19 | 5535 | Malan Const. Co. | 30 Mar 59 | 17 Apr 6 |
| | Warren I | Cheyenne, Wyo. | 25.7 | 26.7 | 26.7 | 16 | 5064 | George A. Fuller Co. | 22 Jul 58 | 19 Aug 5 |
| | Warren II | Cheyenne, Wyo. | 19.9 | 28.1 | 25.2 | 10 | 5498 | Blount Bros. Const. Co. | 11 Mar 59 | 1 Feb 6 |
| | | | 86.6 | 111.5 | 105.9 | | | | | |
| | Warren III | Cheyenne, Wyo. | 28.8 | 32.8 | 33.1 | 5 | 5914 | Martin K. Eby Const. Co. | 4 Dec 59 | 1 May 6 |
| ATLAS E | Fairchild Launchers A, B, C | Spokane, Wash. | | | | | 4816 | Patti-MacDonald-Scott-Leavell | 27 Apr 59 | 5 May 6 |
| | Ops Bldgs A, B & C | | 25.8 | 40.8 | 34.6 | 38 | 4869 | Henry George & Sons | 19 Jun 59 | 6 Mar 6 |
| | Sites D thru I | | | | | | 4897 | Blaw-Knox Corp. | 26 Jun 59 | 1 Aug 6 |
| | Forbes Launchers A, B, C | Topeka, Kans. | | | | | 3821 | Independent Contrs. & Engrs. | 5 May 59 | 1 Jun 6 |
| | Ops Bldgs A, B & C | | 27.5 | 38.0 | 36.8 | 19 | 3874 | Independent Contrs. & Engrs. | 12 Jun 59 | 1 Jun 6 |
| | Sites D thru I | | | | | | 3896 | Blaw-Knox Corp. | 29 Jun 59 | 1 Sep 6 |
| | | | 82.1 | 111.6 | 104.5 | | | | | |
| | Schilling | Salina, Kans. | 37.2 | 48.6 | 48.8 | | 4281 | Utah-Manhattan-Sundt | 7 Mar 60 | 26 Jun 6 |
| | Lincoln | Lincoln, Nebr. | 37.4 | 44.7 | 44.7 | 22 | 6186 | Western Contr. Corp. | 15 Apr 60 | 16 Jul 6 |
| ATLAS F | Altus | Altus, Okla. | 38.8 | 40.8 | 41.5 | 23 | 5909 | Morrison-Knudsen-Hardeman & Assoc. | 27 Apr 60 | 16 Aug 6 |
| | Dyess | Abilene, Tex. | 36.9 | 37.3 | 40.4 | 24 | 5878 | H. B. Zachry Co. & Brown & Root, Inc. | 27 May 60 | 6 Sep 6 |
| | Walker | Roswell, N. Mex. | 42.2 | 41.8 | 40.8 | 24 | 2598 | Macco-Raymond-Kaiser-Puget Sound | 16 Jun 60 | 10 Nov 6 |
| | Plattsburg | Plattsburgh, N.Y. | 43.0 | 43.9 | 44.2 | 24 | 9522 | Raymond-Macco-Kaiser-Puget Sound | 14 Jun 60 | 27 Nov 6 |
| | | | 235.5 | 257.1 | 260.4 | | | | | |
| TITAN I | Lowry I | Denver, Colo. | 91.9 | 118.4 | 118.4 | 18 | 5558 | Morrison-Knudsen Inc. & Assoc. | 17 Apr 59 | 7 Apr 6 |
| | Lowry II | Denver, Colo. | | | | | 5654 | Morrison-Knudsen Inc. & Assoc. | 12 Jun 59 | 1 Jun 6 |
| | Ellsworth | Rapid City, S.D. | 42.7 | 49.6 | 43.2 | 18 | 5919 | Leavell-Scott & Assoc. | 8 Dec 59 | 15 Dec 6 |
| | Beale | Marysville, Cal. | 41.1 | 44.6 | 44.3 | 18 | 2140 | Peter Kiewit Sons Co. | 15 Jan 60 | 1 Feb 6 |
| | Mt. Home | Mt. Home, Idaho | 43.3 | 42.9 | 43.1 | 16 | 3565 | Kaiser-Raymond-Macco-Puget Sound | 8 Feb 60 | 1 Apr 6 |
| | Larson | Moses Lake, Wash. | 46.1 | 45.9 | 45.7 | 33 | 3552 | MacDonald-Scott & Assoc. | 20 Nov 59 | 31 Mar 6 |
| | | | 265.1 | 301.4 | 294.7 | | | | | |
| TITAN II | Davis-Monthan | Tucson, Ariz. | 77.4 | 70.2 | 67.1 | 7 | ** 2 | J. A. Jones Co. | 30 Nov 60 | 15 Jan 6 |
| | McConnell | Wichita, Kans. | 76.2 | 70.0 | 66.9 | 3 | ** 8 | Fuller-Webb-Hardeman | 14 Dec 60 | 15 Feb 6 |
| | Little Rock | Little Rock, Ark. | 76.2 | 69.8 | 66.9 | 3 | ** 9 | Hardaway-Oman-Farnsworth | 21 Dec 60 | 15 Apr 6 |
| | | | 229.8 | 210.0 | 200.9 | | | | | |

# trategy of 'Finite Deterrence'

part of the contents of McNamara's recommendations that were submitted to the White House after a month-long study of U.S. defenses.

Kennedy said McNamara's recommendations "talk about a general strengthening of our Armed Forces including many areas." He specifically said "part of (McNamara's) recommendation is to strengthen conventional forces."

Asked if the recommendations meant a lessening of emphasis on nuclear weapons or U.S. capacity to use them, Kennedy said:

"I have not heard that. We have reached no decision which would indicate that there has been a change in our reliance. If we do reach a change in our reliance in new weapons, we will make it very clear. But no such change has been reached at the present time. What we are anxious to do, of course, is to see conventional forces strengthened, not only in Western Europe but throughout the world."

Kennedy said he expected to complete his study of McNamara's recommendations in about two weeks and he would then send the final version of the Administration's defense recommendations to Congress.

• **Army-Navy score?**—The President's words glossed over what appeared to be a major strategy victory for the Navy and Army.

Both services have charged for years that the Air Force was being allowed to develop an "over kill" capacity while the nation's limited war forces were being starved. Army and Navy planners have said that Russia and the United States were rapidly approaching a period of nuclear stalemate when the beginning of an all-out nuclear war by either side would result in mutual suicide. Therefore, they argued that the United States must build up its limited-war forces to be ready to counter Soviet thrusts around the world.

On the other hand, the Air Force has argued that the United States must maintain strategic forces capable not of retaliating against enemy cities but of surviving an initial attack and destroying the enemy's forces. The Air Force has called this strategy "counter-force" as opposed to "finite deterrence."

In line with current intelligence reports, such a missile force has not been planned for deployment with the next few years. Therefore, if force levels are increased only somewhat, there would—in Kennedy's word—be "no change in our reliance" on nuclear weapons in that sense.

• **Rusk's position**—However, a definite possible shift in U.S. strategy was foreshadowed in the now-famed memo submitted to the Defense Department by Secretary of State Dean Rusk.

Rusk urged an increase in U.S. non-nuclear forces and the playing down of U.S. readiness to use nuclear forces. Rusk's position, later hedged, appeared to be that the United States should not necessarily commit itself in advance to the use of nuclear weapons.

If followed, such a policy could make the defense of Western Europe impossible without a massive buildup of conventional ground armies on the continent.

The Russians are reported to have 20 to 30 divisions ready to march in Eastern Europe.

• **Base 'scramble'**—The testimony released by the House Subcommittee offered a stark look at the difficulties the Administration faces in any plan to speed up deployment of land-based ICBM's.

Contractor after contractor complained to the subcommittee that the program was confounded in a maze of red tape. They charged:

–Modification on top of modification "have not only caused a major increase in the scope of the contract(s) but have drastically changed the character of the work . . . into a confused catch-as-catch-can scramble."

–Contractors are financing the program out of their own money because they are unable to regain unanticipated costs through the fixed-price contract system.

–Construction drawings have been issued in a slipshod fashion with "numerous inaccuracies, inconsistencies and omissions."

–Although contracts are with the Army Corps of Engineers, the Air Force, the architect engineers or the weapon system manager has controlled almost all decisions.

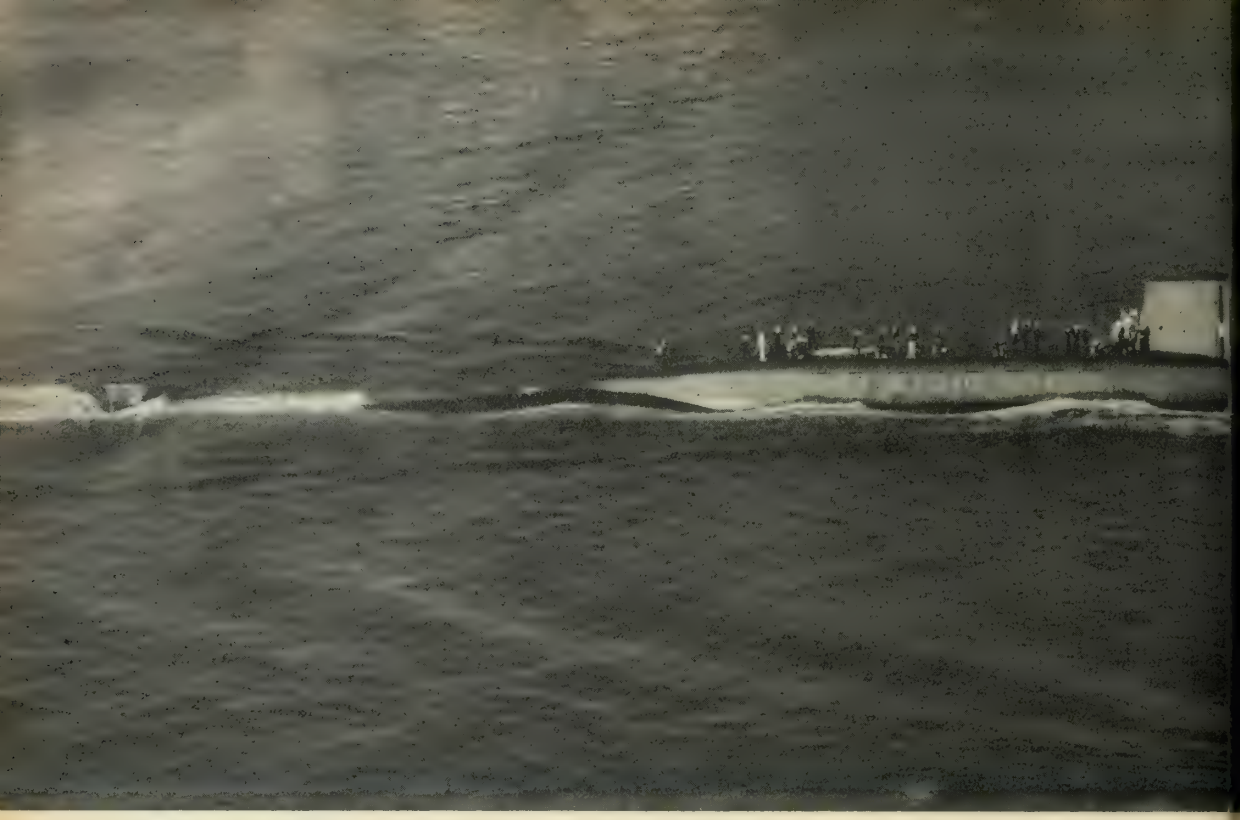
• **Air Force replies**—Joseph Charyk, Undersecretary of the Air Force, charged in a letter to the subcommittee that there were "flagrant misrepresentations" in some of the testimony. He also noted dryly that while the contractors were quick to point out difficulties resulting from frequent change orders they failed to mention that most documents that they received were notices that they were behind in their work.

In rebutting the charges, Charyk offered an interesting insight into the urgency put behind the base-building program by the Eisenhower Administration. He disclosed that construction costs soared $90 million last summer mainly because contractors wrongly concluded from a Pentagon pep talk that expense was secondary to speed.

One thing that the testimony made increasingly clear was that any attempt by the Administration to speed ICBM deployment would call for recognition by all concerned that the effort must be on a wartime scale.

| | SCHED PROGRESS | ACT PROGRESS | ACT OR EST COMPL DATE | ORIG CONTR AMT | CURR CONTR AMT |
|---|---|---|---|---|---|
| 59 | 100 | 100 | 29 Mar 59 | $ 7.1 | $14.1 |
| 59 | 100 | 100 | 20 Aug 59 | 6.0 | 8.6 |
| 60 | 100 | 100 | 4 Aug 60 | 12.9 | 16.7 |
| 59 | 100 | 100 | 30 Sep 59 | 11.8 | 17.9 |
| 0 | 100 | 100 | 25 Jul 60 | 12.4 | 16.5 |
| 61 | 98 | 97 | 1 May 61 | 22.1 | 25.9 |
| 60 | 100 | 100 | 2 Nov 60 | 6.9 | 9.0 |
| 50 | 100 | 100 | 9 Sep 60 | 1.4 | 1.6 |
| 60 | 100 | 99 | 1 Apr 61 | 7.1 | 9.3 |
| 60 | 100 | 100 | 11 Nov 60 | 6.5 | 11.0 |
| 0 | 100 | 100 | 30 Aug 60 | 1.6 | 1.8 |
| 61 | 99 | 97 | 14 Mar 61 | 6.9 | 13.3 |
| 1 | 90 | 88 | 26 Jun 61 | 23.4 | 34.3 |
| 1 | 80 | 80 | 28 Jul 61 | 23.0 | 27.0 |
| 61 | 66 | 70 | 16 Aug 61 | 20.9 | 22.6 |
| 1 | 73 | 62 | 6 Sep 61 | 20.1 | 23.3 |
| 61 | 49 | 34 | 10 Nov 61 | 22.1 | 22.2 |
| 61 | 40 | 29 | 27 Nov 61 | 24.4 | 24.4 |
| 1 | 99 | 97 | 1 Aug 61 | 40.7 | 55.3 |
| 1 | 99 | 95 | 1 Nov 61 | 26.9 | 34.0 |
| 1 | 77 | 81 | 15 Dec 61 | 32.9 | 34.1 |
| 2 | 76 | 83 | 1 Feb 62 | 30.2 | 30.9 |
| 2 | 50 | 50 | 1 Apr 62 | 28.9 | 28.9 |
| 2 | 77 | 72 | 10 Apr 62 | 31.6 | 31.8 |
| 2 | 1.9 | 3.2 | 1 Nov 62 | 27.8 | 27.8 |
| 2 | 1.5 | 2.5 | 1 Dec 62 | 30.8 | 30.8 |
| 2 | 0.4 | 0.8 | 1 Feb 63 | 28.7 | 28.7 |

*Chart from hearings of House Military Construction Subcommittee.*



# Fourth Polaris Submarine Joi

San Diego Union Photo



*'GREATEST SHIP ever built," says Cmdr. W. E. Sims, skipper of one of alternating crews.*

## *USS Theodore Roosevelt heads for firin tests off Canaveral and later modificatio before going on 'on-line' patrol status*

THE THEODORE ROOSEVELT, on its way to th Atlantic Missile Range for firing tests, boosts to fou the nuclear-powered *Polaris* subs in the Atlantic Flee

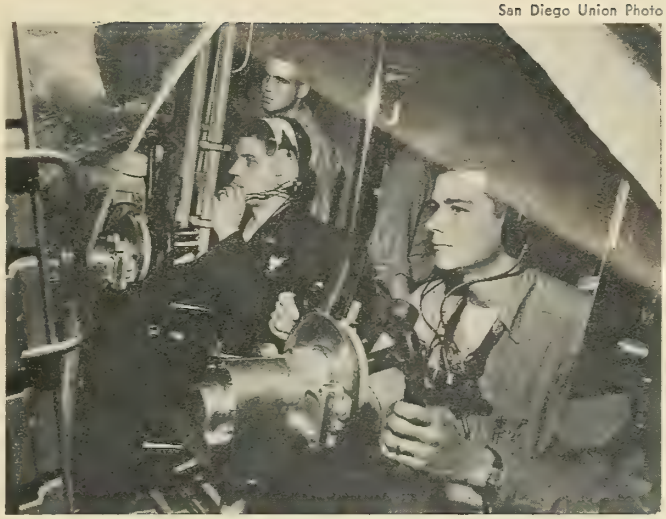
The ship will pick up instrumented *Polaris* missile at the Naval Weapons Annex, Charleston, S.C., the proceed to Port Canaveral, its operational base for th firings.

Before going on "on-line" patrol status in th Atlantic, the ship will put in at Electric Boat Div General Dynamics Corp., Groton, Conn., for modifica tions, including new-design vortex generators to improv the hull's hydrodynamic characteristics.

Although communications remain a problem i transmission from the sub, the "go" signal can be re ceived in a matter of two or three minutes—a reactio time comparable to weapons of the Strategic Air Com mand.

Missiles can be fired in any sea except under ic The guidance computer constantly corrects the missil guidance package in accordance with the ship's move ments. Targets can be changed, if necessary, in a fe minutes.

San Diego Union Photo

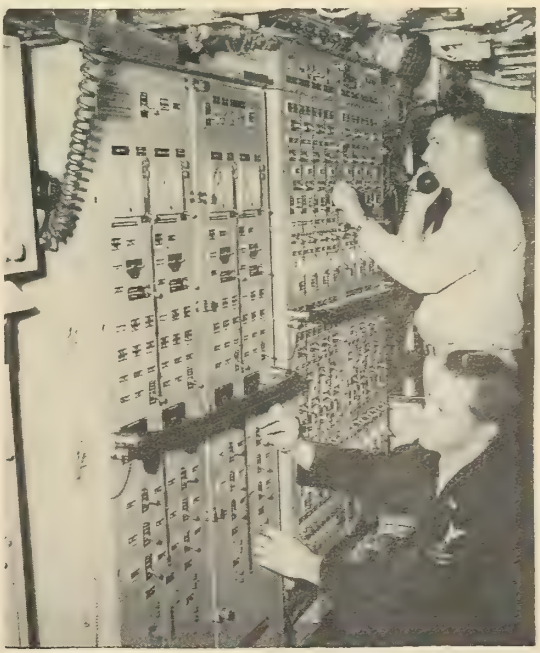


*HELMSMEN PREPARE to take TR down in a 20° dive. Vessel's officially announced operational capability of 400 ft. deep is "conservative."*

# tlantic Fleet



*"MUSHROOM FACTORY"—as ship bottom is called. Polaris launching tubes are shown with hatches at base.*



*LAUNCHING BOARD for all 16 Polarises. The TR can get off all the missiles in its arsenal in less than 15 minutes.*

# Flood Sends M/R Zeus Report to Kennedy

*PRESIDENT KENNEDY is expected to decide shortly whether to commit the Nike-Zeus A—ICBM to limited production (M/R, Jan. 30). The verdict will be included in his overall plans for revamping the defense budget.*

*House Majority Leader John W. McCormack, along with other congressmen, backed immediate production—despite arguments from DOD's Herbert York that Zeus should be proven first.*

*The debate was climaxed when Rep. Daniel Flood of the House Defense Appropriations Subcommittee sent the following letter to Kennedy:*

**Dear Mr. President:**

Sharing your deep, personal concern regarding the manifold aspects of our national security, I send to you this copy of the remarkable series of articles concerning America's antimissile missile weapons systems, the *Nike-Zeus,* which appeared in the Jan. 30 issue of the authoritative technical journal, MISSILES AND ROCKETS magazine.

This series, in my experience, represents the most thorough and comprehensive analysis of a major weapons system presented in public print during these recent years of revolutional progress in science and technology. I have this day sent a copy to every Member of the House of Representatives.

On February 13, in an address to the House, a copy of which I enclose, I expressed the view that this nation needs, and must have as soon as possible, an active defense against incoming intercontinental and subarine-launched ballistic missiles.

I urged that we begin immediate production of the U.S. Army *Nike-Zeus* antimissile missile, America's single weapons system specifically designed to counter the threat of a Red-triggered nuclear hailstorm.

Mr. President, you will recall that as early as 1959 Congress perceived the critical need for this action and appropriated $137,000,000 to initiate production of the first batteries of *Zeus* killer-missiles. The previous Administration failed to act.

In this day of surging breakthroughs in the area of sophisticated weapons systems, the United States cannot afford the loss of a month of critical lead-time. To date, we have lost more than a year of *Zeus* production.

Meantime, intelligence reports reveal that Soviet Russia is laboring at highest priority and with maximum resources to be first in fielding an anti-ballistic missile weapon shield for centers of popul tion, of industry, and of military migh

If the Communists succeed in outpa ing this nation, if they are the first establish the highly effective, specialize defense which neutralizes ballistic pr jectiles, they will seize from the U.S. h present power to retaliate in self-defen against mass-missile attack.

America would sit naked, nuclea weak in the diplomatic councils of th world.

At this crucial juncture of time a events, Mr. President, it is my hope a trust that you will find the enclos article series of significant value in yo contemplation of the moves this nati must make into the new frontiers of n tional and world security.

I profess to you, with all intensity my command, the belief that the Ame can people—and citizens throughout t nations of the Free World—would h a dramatic decision by this Administrati to loose the *Zeus,* to put it into immed ate production, to hasten the day wh U.S. and allied froces at last can sta armed and ready with the ballistic boxi gloves so desperately needed for defen against the ceaseless threat of Co munist world-wide nuclear aggression

# Hughes Develops Optical Space Radar

## *'Colidar' device reported to have desired small size, low weight and power needs—and potential long range*

AN OPTICAL RADAR with a potential range in space of hundreds of miles has been developed by Hughes Aircraft Co.

Called "Colidar" (coherent light detection and ranging), the device uses the monochromatic light from the ruby laser (or optical maser) to beam energy to distant targets. The energy reflected back to a receiver and measured provides information on the size and distance of the target.

Dr. Rex C. Mack, Hughes senior scientist, said that the Colidar has the low weight, low power requirement, and small size that will allow it to be carried in a satellite and provide "the first practical long-range radar for use in outer space."

Hughes was the first to announce successful development of the basic laser (M/R, July 18, 1960). Their announcement of an optical radar, however, followed by almost two weeks the disclosure of a three-mile operating system developed by U. of Michigan (see Technical Countdown, p. 21).

The range of the Colidar is reported to be nearly six miles in the earth's atmosphere. In outer space its range would be hundreds of miles with only a slight expenditure of power, Mack said. The realization of such a practical application is predicated upon expected advances in the state of the art in beam formation, power sources, and receivers.

• **Operation**—The optical radar uses the ruby laser as a transmitter, and an optical system coupled to a photoelectric tube as a receiver.

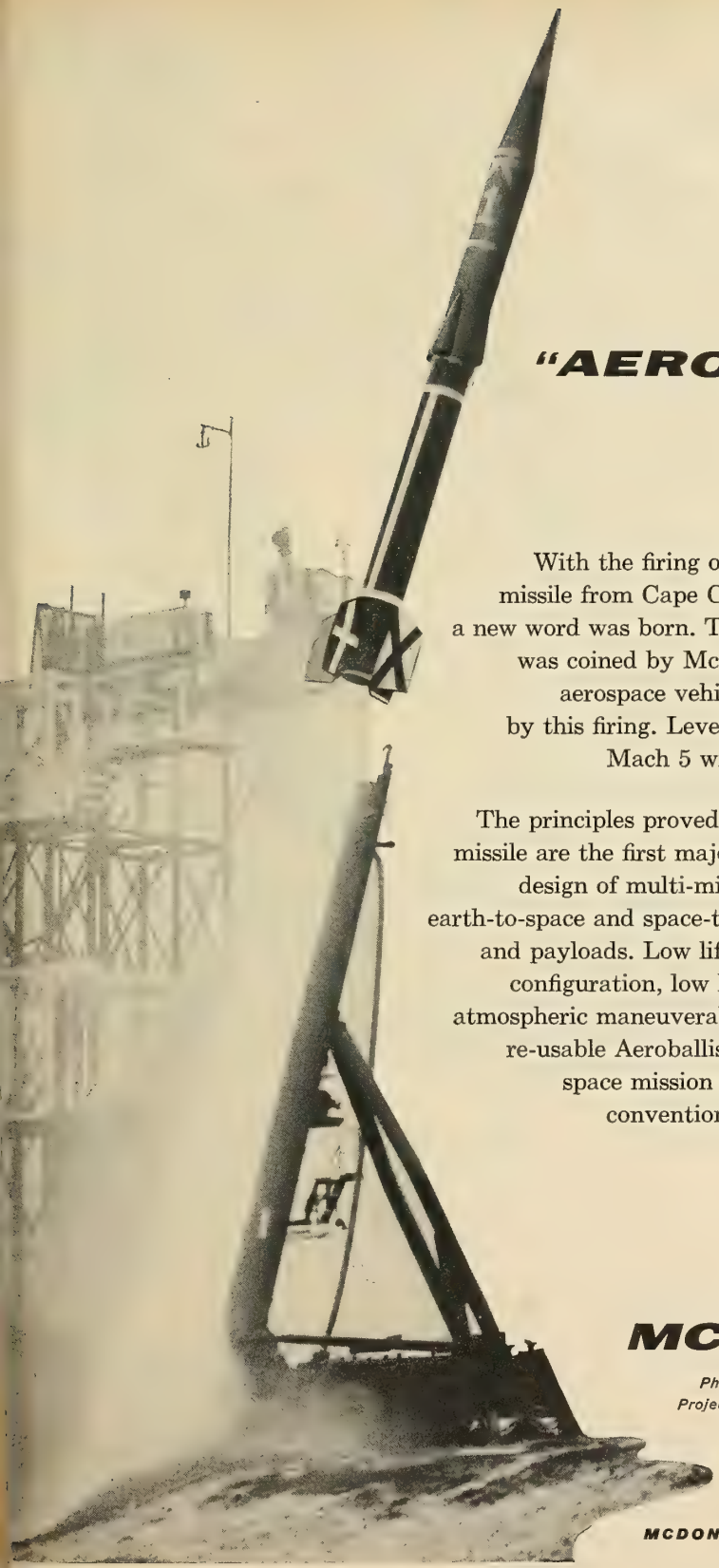
The laser—(light amplication by stimulated emission of radiation) generates a highly collimated, monochromatic beam of light. With the ruby crystal presently used, the wavelength of its radiation is 6943 angstrom units (.00006943 cm).

The ruby crystal is 3/8 in. in diameter and 1½ in. long. Surrounding the ruby is a spiral flash tube. When the flash tube is discharged, the monochromatic beam of red light emerges from the partly transparent silvered surface at one end. Power outputs excess of 1 kw have been observe The beam width is less than ½° an the spectral line width less than 0.( angstroms.

When the output of the laser is fe through a lens system, the beam wid is narrowed down considerably. T very narrow beam width is a desirab feature for optical radar applicati since it ensures a very high gain sy tem—with long range for relative small power requirements—and a ve high angular resolution.

The collector (or receiver) nothing but a telescope. The mirror the telescope collects and focuses t reflected light. After focus, the lig passes through a narrow band lig filter which reduces the "noise" in t returned signal. Finally, the signal amplified and processed.

A portion of the light pulse fro the laser triggers a timing system note the time the pulse is initiate The pulse then travels to the targe is reflected back to the collector, an the elapsed time measured. Range calculated from this measured time.



# "AEROBALLISTIC"

With the firing of this unique hypersonic missile from Cape Canaveral in February 1959, a new word was born. The word, AEROBALLISTIC, was coined by McDonnell to describe the new aerospace vehicle concepts demonstrated by this firing. Level flight was achieved at over Mach 5 within the atmosphere.

The principles proved by McDonnell's Aeroballistic missile are the first major breakthroughs in the design of multi-mission spacecraft for earth-to-space and space-to-earth transport of men and payloads. Low lift-off weight, efficient orbital configuration, low heat re-entry and precise atmospheric maneuverability are provided in a re-usable Aeroballistic vehicle. The Aeroballistic space mission terminates with a conventional runway landing.

## MCDONNELL

*Phantom II and F-101 Fighter and Attack Aircraft •*
*Project Mercury and Aeroballistic Spacecraft •*
*Talos Airframes and Propulsion Systems •*
*Quail Decoy Missiles • Rotorcraft •*
*Electronics Systems • Automation*

**MCDONNELL AIRCRAFT • ST. LOUIS, MO.**



# Today's SERGEANT ranks with the toughest

After some two-score highly successful test firings, the U. S. Army's SERGEANT guided ballistic missile ranks with the toughest and most dependable "sergeants" of history. This "missile behind the man" with its great mobility and swift ability to concentrate massive firepower when and where needed, will provide powerful support to the modern Field Army.

Developed by Jet Propulsion Laboratory, under the direction of the Army Ordnance Missile Command and produced and managed by Sperry Utah, this 85-mile range inertially-guided surface-to-surface missile has met the most exacting design goals of the military. Solid-rocket propelled, it approaches conventional artillery in speed of emplacement and displacement. Its highly precise, inertial guidance system is completely self-contained, requires no external control, is invulnerable to any known countermeasures.

Now being geared for full scale production at Sperry's Salt Lake City facility . . . built and packaged for the roughest handling and environments... SERGEANT when operational, will add formidably to our Nation's arsenal of firepower.

SPERRY
UTAH

*(We invite your inquiry regarding the outstanding opportunities available with the Sperry-Sergeant missile team.)*

**SPERRY UTAH** • *A DIVISION OF SPERRY RAND CORPORATION* • *SALT LAKE CITY, UTAH*



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# Technical Countdown

## ADVANCED MATERIALS

### More Ceramics Research Needed

Increased emphasis on ceramics research is one of the major recommendations contained in a report on new defense research projects compiled by DOD. The report also envisions modifying current programs in metals, semimetals, rare earths, plastics, fabrics, semiconductors and thermo-electric materials.

### Plastic Cases for Giant Solid Boosters?

High-strength steels would be the choice for the motor chambers of multimillion-pound solid boosters if the rockets were to be developed in 13 months. But if the development time is stretched to around 30 months, plastics look very attractive, says Thiokol's Dr. Harold Ritchey.

### Russians Think Ahead

The Soviets have published calculations of the energy necessary to operate a 50-ton vehicle for one year with a photon engine. The initial mass of the theoretical rocket would be 200 tons; conversion of 150 tons of fuel into photons during the period of operation would equal a consumption of $3.76 \times 10^{15}$ kwh. This somewhat exceeds the total amount of electrical energy produced by all of the earth's powerplants during 1957.

## SUPPORT EQUIPMENT

### New Telemetry System Completed

An experimental version of a new telemetry system capable of three times the range of any previous system has been built by General Electric MSVD. It says present systems require about 10 times the power of the new "Synchrolink" digital equipment. The system, classified as PCM/PS (pulse code modulation with phase-shift keying) uses a threshold-free synchronous receiver that permits signal detection at extremely low (about −10 db) S/N ratios.

### Optical Radar Demonstrated

Scientists at U. of Michigan have successfully demonstrated an experimental optical radar. Intense red light from a laser (optical maser) was beamed at a target three miles away and the reflected signals successfully measured. Optical radars should be capable of recording pictures of distant objects with good resolution under conditions unsuitable for conventional cameras. Due to the much higher frequencies used, the laser requires much smaller antennas than does radar.

### Speech Compressor Built for AF

Hughes Aircraft has developed a "voice condenser" for the Air Force that shows promise of relieving present traffic congestion on radio communications channels. Called a "vocoder," the device eliminates extraneous sounds in voice communications and transmits only the basic sounds. In its analog mode, the vocoder requires only one-tenth the frequency bandwidth of conventional channels. It also operates in a digital mode which requires a full bandwidth (3000 cps) but makes the transmission much less subject to interference.

### Navy to Get Outsize Seaborne Radar

A 10-ton attack warning radar—one of the largest ever to go aboard a ship—is now undergoing final test by Raytheon prior to delivery to the Navy. The high-powered AN/SPS-38 is reportedly almost impossible to jam.

### PMR Gets Transit Office

The Navy has assigned Pacific Missile Range full responsibility for establishing, operating, and maintaining the global *Transit* navigational satellite tracking network. The new office at Pt. Mugu is headed by Cdr. J. C. Quillin, Jr. Three *Transit* tracking stations—in Brazil, Alaska, and Hawaii—are already in operation. Six other stations are being planned for locations in the Far East, South Central Asia, and Africa.

### Telemetry Standards Issued

IRIG (Inter-Range Instrumentation Group) has issued its latest telemetry standards (Document No. 106-60), the first complete revision since 1956. The new publication includes recent recommendations for standards for PCM and magnetic recorder reproducers as well as a glossary of terms and frequency criteria. Copies may be obtained from IRIG (White Sands Missile Range) or ASTIA.

### New Computer Uses Pneumatic Elements

A pneumatic digital computer, under development at Kearfott, will be able to operate in temperatures from −100° to +2000°F and in virtually any radiation environment. The new device is said to be equal in certain applications to an electronic or mechanical computer and, in addition, will be smaller, cheaper, more reliable, and easier to service and test. Basic unit of the computer is a bistable element (flip-flop) that operates on compressed gas. Switching time is ten microseconds. Two thousand of these elements, with interconnections, can be packaged in one cubic inch. A complete medium-size pneumatic computer would occupy about the same space as a baseball.

## ASTRONAUTICS

### Contract Let for 'Starched' Echo

Design of the 135-ft. rigidized *Echo* satellite will get under way soon. NASA has awarded a $400,000 contract for R&D, fabrication and testing of rigidized inflatable spheres to G. T. Schjeldal Co., builder of the *Echo I* satellite. The 500-lb. laminated aluminum foil and Mylar spheres —scheduled for first orbit launch next year—are expected to retain their shape in space without internal pressure.

### Contracts for Javelin and Journeyman

Aerolab has a NASA contract to engineer payloads, launch vehicles and analyze data for at least six *Argo D-4 (Javelin)* and several *Argo D-8 (Journeyman)* rockets. *Javelin* has boosted 50 lbs. to 700-800 miles. *Journeyman* launched the *NERV* payload of 83 lbs. to almost 1200 miles last fall.

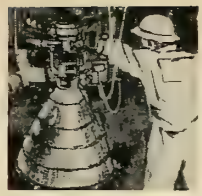


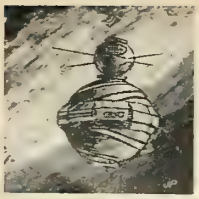

# THIS IS AN ENEMY BOMBER.
# NORTHROP BUILDS IT.

On a radar screen, the RP-76 target missile can look as big as the largest enemy bomber. Rocket powered, it flies faster than sound, operates above 70,000 feet. Yet this little giant is less than ten feet long, weighs just over 300 pounds, and parachutes down for re-use after completing its run. It is the heart of the Army's program for training the ground-to-air missile crews who guard our cities. The complete target and tracking system is made, managed and serviced for the Army by **RADIOPLANE**
A DIVISION OF
**NORTHROP**



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# MISSILES and ROCKETS

# ASTROLOG

Current status of U. S. missile and space programs plus all orbiting satellites



## Satellites and Spacecraft

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**ADVENT** (Army) | Army Signal Corps, prime; GE-Bendix prime for polar-orbiting phase; Bendix prime for 24-hour satellite | Twenty-four hour instantaneous repeater communications satellite; 1000 lbs.; program incorporates Projects STEER and DECREE | R&D; ground sites to be equipped at Ft. Dix, N.J., and Camp Roberts, Calif.; shipboard terminals also being designed; first ATLAS-CENTAUR launchings late '62 |
| **ANNA** (Army, Navy, AF, NASA) | No contractors announced | Geodetic satellite; 50-100 lbs.; probably spherical | Study completed; R&D program appears imminent |
| ★**AEROS** (NASA) | No contract announced | 24-hour weather satellite to be boosted by CENTAUR or SATURN | Planning. First flights would be in 1964 or 1965; unfunded FY '62 budget |
| **APOLLO** (NASA) | Convair, Martin, GE | Three-man spacecraft capable of orbiting moon or becoming space station; probably winged for lunar flights; boosted by SATURN | Six-month studies in progress; plans delayed |
| ★**ARENTS** (ARPA) | Convair, prime | Satellites to investigate deep space; 22,000 n. mi. orbits; ATLAS-CENTAUR booster | Contract let to build three payloads; launchings begin early '62 |
| **ASP** (Air Force) | No contracts announced | Aerospace plane, a manned spacecraft capable of operating in the atmosphere and space | Study |
| **BAMBI** (ARPA) | No contracts announced | Satellite system capable of intercepting enemy satellites | Studies |
| ★**COURIER** (Army) | Army Signal Corps, prime; Philco, payload; Radiation, Inc., antennas; ITT, ground stations | Delayed repeater communications satellite; 51 in. diameter, 500 lbs. | COURIER 1B placed in orbit Oct. 4, transmitted messages and pictures. Program now phased into ADVENT |
| **CSAR** (Air Force) | No contracts announced | Communications satellite system; satellites to weigh possibly two tons; to use passive lens reflectors | Studies; possibly operational mid-60's |
| ★**DISCOVERER** (Air Force) | Lockheed, prime; GE, re-entry vehicle | THOR-AGENA and ATLAS-AGENA launchings of early stabilized satellites; main purpose is to test techniques for military space systems | Launchings: 21; capsules recovered from orbit and air snatched; after orbiting earth one to three days; simians to be put in capsules in early 1961 |
| ★**DYNA-SOAR I** (Air Force) | Boeing, spacecraft and systems integrator; Martin, propulsion; Minneapolis-Honeywell, guidance; RCA, communications data link | Boost-glide orbital spacecraft; R&D leading to first space bomber; TITAN II booster | R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway; R&D space flight about 1966 |

★ **Indicates change since January, 1961 Astrolog**

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| ★**ECHO** (NASA) | Langley Research Center, prime | Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite | In orbit since Aug. 12 |
| ★**MARINER** (NASA) | JPL, prime | 600-1200 lb. unmanned spacecraft for early interplanetary missions; boosted by ATLAS-AGENA B | Seven shots planned. First scheduled Venus fly-by Aug. 1962 |
| ★**MERCURY** (NASA) | NASA, prime; McDonnell, capsule | First manned satellite; 1 ton capsule boosted by ATLAS | First manned capsule launching by REDSTONE now scheduled this spring. First manned orbit shot expected late 1961 or early 1962. Chimp in capsule launched successfully downrange by REDSTONE Jan. 31; ATLAS-capsule shot with fix succeeded Feb. 21 |
| ★**MIDAS** (Air Force) | Lockheed prime; Aerojet, IR detector system | Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites | R&D; second launching May 24 partial success; components being tested by DISCOVERER |
| ★**NIMBUS** (NASA) | GE prime | 2nd generation weather satellite; THOR-AGENA B booster | First launching scheduled for late 1962 |
| **OAO** (NASA) | Grumman, prime; Westinghouse, electronic components | 3500-lb. orbiting astronomical satellite observatory equipped with telescope; boosted by ATLAS-AGENA B | First flight scheduled in late 1963 |
| **OGO** (NASA) | Space Technology Laboratories, prime | 1000-lb. satellites with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; ATLAS-AGENA B, THOR-AGENA B, CENTAUR boosters | First flight scheduled in 1963 |
| ★**OSO** (NASA) | Ball Brothers, prime | 350 lb. orbiting solar observatory; THOR-DELTA booster | First flight planned summer 1961 |
| **PROSPECTOR** (NASA) | No contract announced | Soft-landed, remote control, unmanned moon exploring spacecraft. SATURN booster | First flight planned by 1965; study contracts to be awarded in 1961 |
| **RANGER** (NASA) | JPL, prime; Aeronutronic, capsule; Hercules, retrorocket | 300-lb. rough landed instrumented capsule on moon; ATLAS-AGENA B booster | R&D; first flight planned 1961; first lunar landing planned for 1962, instrumentation to include seismometer |
| ★**REBOUND** (NASA) | No contract announced | System of 12 or more multi-launched passive communications satellites | First orbital flight scheduled for 1962 |
| ★**RELAY** (NASA) | No contracts announced | Systems of dozens of 85-lb. active repeater communications satellites. Commercial system planned | Contract to be awarded soon |
| **SAINT** (Air Force) | RCA, prime | Anti-satellite satellite inspection system; to be complemented by interception system; ATLAS launched | R&D underway |
| ★**SAMOS** (Air Force) | Lockheed, prime | Reconnaissance satellite; formerly SENTRY; R&D model weighs 4100 lbs. | R&D; SAMOS II successfully launched Jan. 31 from Vandenberg. First launch failed to put SAMOS in orbit Oct. 11; scheduled to be operational late 1962, early 1963 under new, bigger program; components being tested in DISCOVERERS |
| **SLOMAR** (Air Force) | Lockheed and Martin, prime | Logistics, maintenance, supply spacecraft for space systems | Study contracts awarded in December |
| ★**SURVEYOR** (NASA) | Hughes, prime | Soft-landing 100-300 lbs. instrumented spacecraft on moon; ATLAS-CENTAUR booster | First moon flights 1963 |
| **TIROS** (NASA-AF-Army-Navy-Wea. Bu.) | RCA-Army Signal Corps, prime | Meteorological satellite; TV pictures of cloud cover; TIROS II carried IR scanner | R&D; first launching last April; second Nov. 23, both successful. At least one more planned |
| ★**TRANSIT** (Navy) | Applied Physics Laboratory, prime | Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50-100 lbs. | TRANSIT IB R&D satellite in orbit April 13; IIA plus piggyback satellite in orbit June 22, four-satellite TRANSIT system scheduled operational 1962; TRANSIT IIIB lanuched into poor orbit Feb. 21 |
| **VOYAGER** (NASA) | No contract announced | Unmanned spacecraft to orbit Mars or Venus; eject capsule for re-entry; SATURN booster | Study; first flight planned by 1965 |
| **YO YO** (Navy) | No contract announced | Tactical sea-launched one-pass reconnaissance satelloid | R&D |
| ★**X-15** (NASA-AF-Navy) | North American, prime; Thiokol, propulsion | Rocket plane; 4000 mph; flight at edge of space; on AF model each XLR-11 rocket engine develops 16,000 lbs. of thrust; XLR-99 engines 50,000 lbs. Three planes delivered. | Powered flights in progress; plane #1 has hit Mach 3 and more than 136,500 ft. with XLR-11 engine; plane #2 with XLR-99 engine turned over to NASA |



# Missiles and Rockets

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **ALFA** (Navy) | Navy, prime; Avco, air frame | ASW surface-to-underwater; 500 lb. solid; conventional | Deployed on destroyer escorts |
| **ARM** (Air Force) | No contract announced | Anti-radar missile; air to surface | Studies; plan for separate missile shelved at least temporarily |
| **ASROC** (Navy) | Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H | Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional, range about 8 miles; advanced ASROC (improved Mark 44 torpedo) under R&D | R&D; operational on Destroyers Norfolk, Adams, Dewey and Perry; plans call for deploying on 150 destroyers and cruisers |
| **ASTOR** (Navy) | Westinghouse, prime | ASW underwater to underwater rocket torpedo; nuclear | R&D |
| ★**ATLAS** (Air Force) | Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE/Avco, re-entry vehicle | ICBM; more than 5500-to-7500 mile range; liquid; nuclear; ATLAS "E" series has inertial guidance; earlier ATLAS "D" has radio inertial; proposed ATLAS "G" would have 900,000-lb. thrust and 4000-lb. payload capability | 79 launchings; 51 successes, 12 partial, 16 failures; 11 bases for 13 squadrons; operational at Vandenberg and Warren; ATLAS E tests began Oct. 11; about 9 to 12 launchers operational—40 to 60 expected in 1961. First successful "E" shot Feb. 24 |
| **BOMARC-A** (Air Force) | Boeing, prime; IBM/Westinghouse, guidance; Aerojet/Marquardt, propulsion | Ramjet surface-to-air interceptor; liquid booster; 250 m. range; Mach 2.7; nuclear | First squadron operational at McGuire AFB, N.J. |
| **BOMARC-B** (Air Force) | Boeing, prime; Kearfott/Westinghouse, IBM Guidance; Thiokol/Marquardt, propulsion | Ramjet, surface-to-air; solid booster; Mach 2.7; more than 400 m. range; nuclear | B models being produced; a B test bird intercepted simulated target 345 miles away Oct. 14; R&D launchings: 18; 10 successes; 8 failures |
| ★**BULLPUP** (Navy-Air Force) | Martin, prime; Martin, guidance; Thiokol, Naval Propellant Plant, propulsion | Air-to-surface; 3-6 mile range; conventional 250-1000-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model nearly operational; AF designation: GAM 83-A (HE warhead), GAM 83-B (nuclear) | Deployed with Atlantic and Pacific Fleets; bigger model under R&D; soon operational with Air Force units. Marines launching BULLPUP from helicopters; second source contractor being sought |
| **COBRA** (Navy) | No contract announced | Anti-ship radar missile | Early R&D |
| **COBRA** (Marines) | Boelkow Entwicklungen, West Germany, prime manufacturer; Daystrom, U.S. licensee | 20.2-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant | Marines planning to purchase; Army considering them; already operational with West German troops |
| **CORPORAL** (Army) | Firestone, prime; Gilfillan, guidance; Ryan, propulsion | Surface-to-surface; 75-mile range; liquid; nuclear | Deployed with U.S. & NATO troops in Europe |
| **CLAYMORE** (Army) | No contract announced | Anti-personnel missile | R&D |
| **CROW** (Navy) | No contract announced | Air-to-air missile | R&D; has been flight tested |
| **DAVY CROCKETT** (Army) | In-house project directed by Rock Island, Ill., arsenal | Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men | R&D; operational this year; first NATO deliveries also this year |
| ★**EAGLE** (Navy) | Bendix, prime; Bendix, guidance; Aerojet, propulsion; Grumman, airframe | Air-to-air; 100-mile range; nuclear; for launching from relatively-slow Douglas Missileers now under development; EAGLE is 15 ft. long; wt., about 2000 lbs.; Mach 4; solid | R&D; Missileer production run reported to be 120 in next few years if plane refunded; first EAGLE flight test expected early '62 |
| **FABMIDS** (Army) | Convair, Hughes, Martin, GE, Raytheon, Sylvania—feasibility studies | Mobile anti-missile defense system | Each of six contractors have $250,000 feasibility study contracts awarded Oct. 10; reports expected mid-'61 |
| **FALCON** (Air Force) | Hughes, prime; Hughes, guidance; Thiokol, propulsion | Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead | GAR-1 through GAR-4 operational; GAR-9 R&D; GAR-11 operational in near future |
| **GENIE** (Air Force) | Douglas, prime; Aerojet-General propulsion | Air-to-air; unguided; 1.5-mile range; nuclear | Operational |
| **GIMLET** (Navy) | No contract announced | Air-to-surface; unguided; considered highly accurate | R&D |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **HAWK** (Army) | Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion | Surface-to-air; 22-mile range; solid; conventional; designed to hit low-flying planes | Operational; deployed at Panama, Okinawa; SUPER HAWK under development; Jan. 29, 1960 successfully intercepted HONEST JOHN, first known missile intercept of another |
| **HONEST JOHN** (Army) | Douglas/Emerson Electric, prime; Hercules, propulsion | Surface-to-surface; unguided; 12-mile range; nuclear | Operational; deployed in Europe |
| **HOUND DOG** (Air Force) | North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion | Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear | Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400 |
| **JUPITER** (Army) | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear/CTL, re-entry vehicle | IRBM; liquid; nuclear; can be made mobile | To be deployed with Italian and Turkish troops. 31 military launchings: 24 successes; 5 partials; 2 failures. Full tactical GSE used for first time in Oct. 20 shot from Cape |
| ★**LACROSSE** (Army) | Martin, prime; Martin, guidance; Thiokol, propulsion | Surface-to-surface; highly mobile; 20-mile range; solid; nuclear | Operational; three units deployed in Europe; more being trained; advanced LACROSSE R&D dropped |
| ★**LAW** (Army) | Hesse-Eastern Div., Flightex Fabrics, prime | Light anti-tank rocket; carrier tube launcher; 4.5 lbs.; 25 in. long/3 in. diameter | R&D under AOMC |
| ★**LITTLE JOHN** (Army) | Emerson Electric, prime; Hercules Powder, propulsion | Surface-to-surface; unguided; 10-mile range; solid; nuclear | First 4-launcher battalion operational this winter |
| **LOBBER** (Army) | No contract announced | Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA | Studies |
| **LULU** (Navy) | General Mills/Naval Ordnance Lab, prime | Small nuclear depth charge air-dropped or launched by ASROC | Operational |
| ★**MACE** (Air Force) | Martin, prime; Goodyear/AC Spark Plug, guidance; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has more than 1200 m. range | Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D; to be in Okinawa, Korea |
| **MATADOR** (Air Force) | Martin, prime; Thiokol/Allison, propulsion | Air-breathing surface-to-surface; 650-mile range | Being turned over to West Germans; also deployed in Far East |
| **MAULER** (Army) | Convair, prime | Surface-to-air; radar guidance; highly mobile antiaircraft and antimissile missile for field use; on tracked vehicle; 12 missiles per launcher | R&D; NATO may buy |
| ★**MINUTEMAN** (Air Force) | Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Hercules, third stage; Avco, re-entry vehicle; AMF-ACF rail launcher | 2nd generation ICBM; solid; fixed or mobile aboard railroad trains; nuclear; 3 stages | R&D; scheduled to be operational mid-1962 at Malmstrom AFB; first R&D flight (all stages igniting) from Cape Feb. 1 a success; tactical rail system tests completed; 3 squadrons at Malmstrom; 3 at Ellsworth AFB, S.D.; Pease AFB, N.H., being surveyed for more |
| **M-55** (Army) | Norris Thermador, prime | Four-inch diameter, small, short-range poison gas rockets; to be fired from 45-tube launchers | Operational |
| **MISSILE A** (Army) | ARGMA prime | Surface-to-surface; 10-20 mile range; solid | Design studies |
| **NIKE-AJAX** (Army) | Western Electric, prime; Western Electric, guidance; Thiokol propulsion | Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional | Deployed in U.S., Europe & Far East; about 170 batteries in U.S. sixty-eight more to be phased out and replaced with NIKE-HERCULES |
| ★**NIKE-HERCULES** (Army) | Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion | Surface-to-air; 75-mile range; Mach 3+; nuclear; anti-aircraft, tactical missiles; mobile or fixed | Rapidly replacing NIKE-AJAX; well over 80 batteries deployed in U.S.; more than 10 N-H batteries being deployed overseas in 1961; N-H on Formosa |
| ★**NIKE-ZEUS** (Army) | Western Electric, prime; Bell Telephone, guidance; Thiokol/Grand Central, propulsion | Anti-missile; 3-stage; 200-mile range; solid; nuclear | R&D test launchings at White Sands, 14 R&D launchings; 8 successful, 4 partial, 2 failures. Complete system tests now scheduled for mid-'62 |
| ★**PERSHING** (Army) | Martin, prime; Bendix, guidance; Thiokol, propulsion | Surface-to-surface; two-stage solid; approx. 500-mile range; nuclear; transported on FMC XM474 tracked vehicle; proposed PERSHING II would have 1000-mile range | R&D; to replace REDSTONE; 12 R&D launchings: 10 successes (both stages launched, guidance carried as passenger Dec. 12 for first time), 2 failures. Operational late 1961 |

| | | | |
|---|---|---|---|
| ★**POLARIS** (Navy) | Lockheed, prime; GE/MIT, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle | Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear; POLARIS II (1500-mile range) and SUPER POLARIS (2500 mile range) under R&D | 87 launchings of test vehicles; 61 successes; 21 partial; 5 failures; 15 also launched from submerged subs —all cleared surface; 10 successful flights, 5 failures. Two subs each with 16 missiles operational; Total authorized: 19. Cruiser Long Beach also to get 8 missiles |
| **QUAIL** (Air Force) | McDonnell, prime; Summers Gyro, guidance; GE, propulsion; Ramo-Wooldridge, ECM equipment | ECM-carrying bomber decoy; about 200 m. range; jet powered | Deployed at SAC bases; carried by B-52 |
| **RAVEN** (Navy) | No contract announced | Air-to-surface; about 500-mile range | Study |
| **REDEYE** (Army) | Convair, prime; Philco/Convair Atlantic Research, propulsion | Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable | R&D: Marines also will use; NATO may be, |
| **REDSTONE** (Army) | Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion | Surface-to-surface; liquid; 200-mile range; nuclear | Deployed with U.S. troops in Europe; to be replaced by PERSHING |
| **REGULUS I** (Navy) | Chance Vought, prime and guidance; Aerojet-General, propulsion | Surface-to-surface; turbojet & solid; 500-mile range; nuclear | Deployed aboard U.S. submarines; REGULUS II used as target drone |
| **SEMPER** (Marines) | No contracts announced | Believed to be an air-launched missile | R&D testing at Pt. Mugu |
| **SERGEANT** (Army) | Sperry, prime; Sperry, guidance; Thiokol, propulsion | Surface-to-surface; solid; more than 75-mile range; nuclear | In production |
| **SHILLELAGH** (Army) | Aeronutronic, prime | Surface-to-surface; lightweight; can be vehicle-mounted | Early R&D |
| **SIDEWINDER** (Navy-Air Force) | GE-Philco, prime; Philco/GE guidance; Naval Powder Plant, propulsion | Air-to-air; IR guidance; more than 2 m. range; conventional; new I-C models to have switchable IR and radar-guided warheads | Deployed with Navy and Air Force; all-weather type under development |
| ★**SKY BOLT** (Air Force) | Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle | ALBM; more than 1000-mile range; solid; nuclear; to be launched from B-52, B-70 and Vulcan bombers | R&D; to be purchased by British; operational 1964-65; test-launching to be from Eglin AFB, Fla. Spending cut jeopardizing program schedule |
| **SLAM** (Air Force) | No contract announced | Surface-to-surface; low-altitude; supersonic; nuclear ramjet and warhead | Study-R&D |
| **SNARK** (Air Force) | Norair, prime; Northrop, guidance; Pratt & Whitney/ABL, propulsion | Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear | One squadron of about 20 missiles at Presque Isle, Maine |
| **SPARROW III** (Navy) | Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion | Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional | Operational with carrier aircraft; earlier SPARROW I obsolete; new contract extending range, altitude |
| **SUBROC** (Navy) | Goodyear, prime; Kearfott, guidance; Thiokol, propulsion | Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear | Estimated operational date: 1961. To be installed first on Thresher nuclear-powered attack submarine |
| **SS-10** (Army) | Nord Aviation, prime; GE, U.S. licensee | Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional | Operational with U.S., French and other NATO and Western units; battle-tested in North Africa |
| **SS-11** (Army) | Nord Aviation, prime; G.E., U.S. licensee | Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional | Operational. Under evaluation by Army; decision on procurement due for some time |
| **TALOS** (Navy) | Bendix, prime; Bendix/Sperry, guidance; Naval Propellant Plant, propulsion | Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear | Operational aboard cruiser Galveston |
| **TARTAR** (Navy) | Convair, prime; Raytheon, guidance; Aerojet-General, propulsion | Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional | Operational on Missile Destroyer Adams in Oct. |
| **TERNE** (Navy) | Kongsberg Vapenfabrikk, prime; Arma, systems integration | Surface-to-underwater ASW missile; 264 lbs.; HE warhead | Navy buying from Norway to equip two destroyer escorts |
| **TERRIER** (Navy) | Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion | Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional | Operational with fleet |
| **TERRIER-ADVANCED** (Navy) | Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion | About 100% performance improvement over TERRIER | Operational Advanced TERRIERS to be deployed this year |
| ★**THOR** (Air Force) | Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle | Surface-to-surface IRBM; 1500-mile range; liquid; nuclear | Operational; 4 bases set up in England. 65 military launchings: 44 successes; 11 partial; 10 failures; 44 scientific launchings: 36 successful, 2 partial; 6 failures |
| ★**TITAN** (Air Force) | Martin, prime; Bell/Sperry, TITAN I guidance; AC Spark Plug, TITAN II guidance; Aerojet-General, propulsion; Avco, TITAN I re-entry vehicle; GE, TITAN II re-entry vehicle | Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear; TITAN I burns LOX-Kerosene; TITAN II has storable propellants, inertial guidance, bigger payload, greater range, 115 ft. long TITAN III proposed | 29 launchings test vehicles: 19 successes; 4 partial; 6 failures. 9 sites for 14 squadrons named; TITAN I operational mid-1961 despite delay caused by silo blow-up at Vandenberg; TITAN II scheduled operational early 1963 |

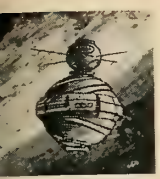
| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **TYPHON** (Navy) | Westinghouse, prime; Bendix propulsion | Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic | Early R&D; may be used on hydrofoil destroyers |
| **WAGTAIL** (Air Force) | Minneapolis-Honeywell, prime | Air-to-ground; low-level; solid; designed to climb over hills and trees | R&D |
| **WILLOW** (Army) | Chrysler, prime | Highly-classified missile | R&D |
| **ZUNI** (Navy) | Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion | Air-to-air, air-to-surface; solid; unguided; 5-m. range; conventional | Operational |



# Space Vehicles

| | | | |
|---|---|---|---|
| **AGENA** (Air Force) | Lockheed, prime; Bell, propulsion | 1700-pound satellite after burnout; AGENA B stop-start engine about double fuel capacity of AGENA A | Used in DISCOVERER program; larger AGENA B also to be used with ATLAS and THOR |
| **ATLAS-ABLE** (NASA) | STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion | Orbit 380-lb. vehicle around moon or send into deep space | Program ended with explosion of booster in flight Dec. 14. Launchings: 4; failures, 4 (3 failed in flight) |
| ★**BLUE SCOUT** (Air Force) | Aeronutronic, prime; Minneapolis-Honeywell, guidance; Aerojet/Hercules, Thiokol, propulsion | Solid multi-stage booster based on SCOUT components | Launchings 3:2 successes; 1 partial |
| **CENTAUR** (NASA) | Convair, prime; Pratt & Whitney, propulsion; Minneapolis-Honeywell, guidance | Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable orbiting 8500 lbs. launching 1450-lb. space probe | First test flight in 1961; first engine delivered |
| ★**DELTA** (NASA) | Goddard, prime; Douglas, booster; Bell, guidance; Rocketdyne/Aerojet/ABL, propulsion | Successor to THOR-ABLE; upper stage guidance; 480 lb. payload capacity | Interim launch vehicle for TIROS ECHO; being used for other satellites and one deep space probe |
| **JUNO II** (NASA) | Marshall Center/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, propulsion | Early deep space booster; small payload | Phasing out |
| **NOVA** (NASA) | No prime announced; Rocketdyne, propulsion | Clustered 6-12 million lb. booster plus upper stages | R&D on 1.5 million lb. F-1 engine |
| **ORION** (Air Force) | General Atomic | Space station launched by series of atomic explosions | Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone |
| ★**PHOENIX** (Air Force) | No contracts announced | Recoverable booster—possibly a modified F-1. | Studies |
| **PROJECT 3059** | Aerojet-General, Grand Central, propulsion | Solid motor in 1 million to 2 million lbs. thrust class | Research determining feasibility; NASA contracting complementary studies with United Technology |
| ★**ROVER** (NASA, AEC) | No prime announced | First nuclear rocket: KIWI non-flying test engines and NERVA flight engines | Contracts to be let early 1961 |
| ★**SATURN** (NASA) | Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines | Series of multistage vehicles based on 1.5-million-lb. clustered booster and various upper stages of LOX-liquid hydrogen engines. Early model to orbit 20,000-lb. payload | Second static tests ended; flight booster to be static-tested this spring for summer flight; flight with live upper stages scheduled 1963 |
| ★**SCOUT** (NASA) | Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Hercules/Thiokol/ABL, propulsion | Solid four-stage satellite launcher; 200 lb. payload in orbit | SCOUT 4 launched. EXPLORER IX Feb. 16. Four more SCOUT flights in '61 completes R&D |

| PROJECT | CONTRACTORS | DESCRIPTION | STATUS |
|---|---|---|---|
| **THOR-ABLESTAR** (Air Force-NASA) | STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion | Three-stage vehicle, orbital capability 800 lbs. Upper stage has restart engine | THOR-ABLE phased out. THOR-ABLESTAR operational in TRANSIT and COURIER |
| **THOR-AGENA** (Air Force) | Lockheed, prime; Bell, propulsion | Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs. | Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61 |



# Satellites in Orbit

**EXPLORER I** (30.8 lbs.) U.S. Launched 1/31/58, est. life 7-10 years. Orbits earth; perigee 220 m., apogee 1129 m., period 106.8 min. Discovered Van Allen Belt); not transmitting.

**VANGUARD I** (3.25 lbs.) U.S. Launched 3/17/58, est. life 200-000 years. Orbits earth; perigee 407, apogee 2444, period 133.8; ransmitting.

**UNIK I "MECHTA"** (3245 lbs.) Russia. Launched 1/2/59. Believed o be in orbit around Sun on 15-mo. cycle; not transmitting.

**VANGUARD II** (20.7 lbs.) U.S. Launched 2/17/59, est. life 100-50 years. Orbits earth but is "wobbling"; perigee 343, apogee 2052, eriod 125.4; inclination to equator 32.88°; not transmitting.

**IONEER IV** (13.4 lbs.) U.S. Launched 3/3/59. Orbits Sun, and chieved primary mission—earth-moon trajectory; not transmitting.

**EXPLORER VI "PADDLEWHEEL"** (142 lbs.) U.S. Launched 8/7/59, st. life to Aug., 1961. Orbits earth; initial perigee 156, initial pogee 26,357, initial period 12½ hrs.; present orbit uncertain.

**VANGUARD III** (about 100 lbs.) U.S. Launched 9/18/59, est. fe 50-150 years. Orbits earth; perigee 315, apogee 2318, period 29.8; not transmitting.

**EXPLORER VII** (91.5 lbs.) U.S. Launched 10/13/59, est. life 30-40 ears. Orbits earth; perigee 344, apogee 671, period 101.2; trans-nitting.

**PIONEER V** (94.8 lbs.) U.S. Launched 3/11/60, est. life forever. Orbits Sun, interplanetary environment probe; completed one full rbit 1/16/61; not transmitting.

**TIROS I** (270 lbs.) U.S. Launched 4/1/60, est. life 50-150 years. Orbits earth; picture-taking weather satellite; perigee 429, apogee 57, period 99.1; transmitting.

**TRANSIT IB** (265 lbs.) U.S. Launched 4/13/60, est. life 6 years. Orbits earth; perigee 229, apogee 426, period 95.1. First R&D avigation satellite. Not transmitting.

**SPUTNIK IV** (10,008 lbs.) Russia. Launched 5/15/60, est. life 2-3 ears. Orbits earth; initial perigee 188, apogee 229—changed to 1/429 on 5/19; last reported—perigee 175, apogee 352, period 8.1 Test of support systems, cabin, for manned space flight; attempt return from orbit failed; payload, case and two pieces now in bit. Not transmitting.

**MIDAS II** (5000 lbs.) U.S. Launched 5/24/60, est. life 8-15 years. rbits earth; perigee 296, apogee 317, period 94.3. Telemetry for scanning failed two days after launch. Not transmitting.

**RANSIT II-A** (223 lbs.) U.S. Launched 6/22/60, est. life 50-200 ars. Orbits earth, perigee 389, apogee 650, period 101.6; trans-itting.

**NRL SOLAR RADIATION SATELLITE I** (40 lbs.) U.S. Launched 6/22/60 with TRANSIT II-A, est. life 50-200 years. Orbits earth; perigee 381, apogee 657, period 101.6. Transmitting.

***ECHO I** (132 lbs.) U.S. Launched 8/12/60, est. life 2-16 years. Orbits earth; perigee 624, apogee 1305, period 117.1. First successful orbiting of passive communications satellite.

***COURIER IB** (500 lbs.) U.S. Launched 10/4/60, est. life 200-500 years. Orbits earth; perigee 604, apogee 751, period 106.9. First successful launching of delayed active repeater satellite. Transmitting.

***EXPLORER VIII** (90 lbs.) U.S. Launched 11/3/60 by JUNO II, est. life 20-50 years. Orbits earth, perigee 304, apogee 1371, period 112.6. Provides ionospheric measurements for communications. Transmitting.

***TIROS II** (280 lbs.) U.S. Launched 11/23/60, est. life 200-500 years. Orbits earth; perigee 378, apogee 461, period 98.2. Transmitting.

***DISCOVERER XVIII** (2100 lbs.) U.S. Launched 12/7/60. Orbits earth; perigee 143, apogee 300, period 91.7. Capsule air-snatched and recovered after 48 orbits; contained human bone marrow, cancer cells, other biological specimens.

***SAMOS II** (4100 lbs.) U.S. Launched 1/31/61. Orbits earth. First R&D reconnaissance satellite.

***SPUTNIK VII** (14,292 lbs.) Russia. Launched 2/4/61. Orbits earth; perigee 120, apogee 186, period 89.4. Not transmitting.

***VENUS PROBE** (1419 lbs.) Russia. Launched 2/12/61. Expected to reach Venus by mid-April.

***SPUTNIK VIII** Russia. Launched 2/12/61. Orbits earth; perigee 123, apogee 198, period 89.7. Launch platform for VENUS PROBE.

***EXPLORER IX** (15 lbs.) U.S. Launched 2/16/61. Orbits earth; perigee 394, apogee 1607, period 118.4. A 12-ft. "polka dot" balloon.

***DISCOVERER XX** (2450 lbs.) U.S. Launched 2/17/61. Orbits earth; perigee 201, apogee 450, period 95. No attempt to recover 300-lb. capsule because of malfunction.

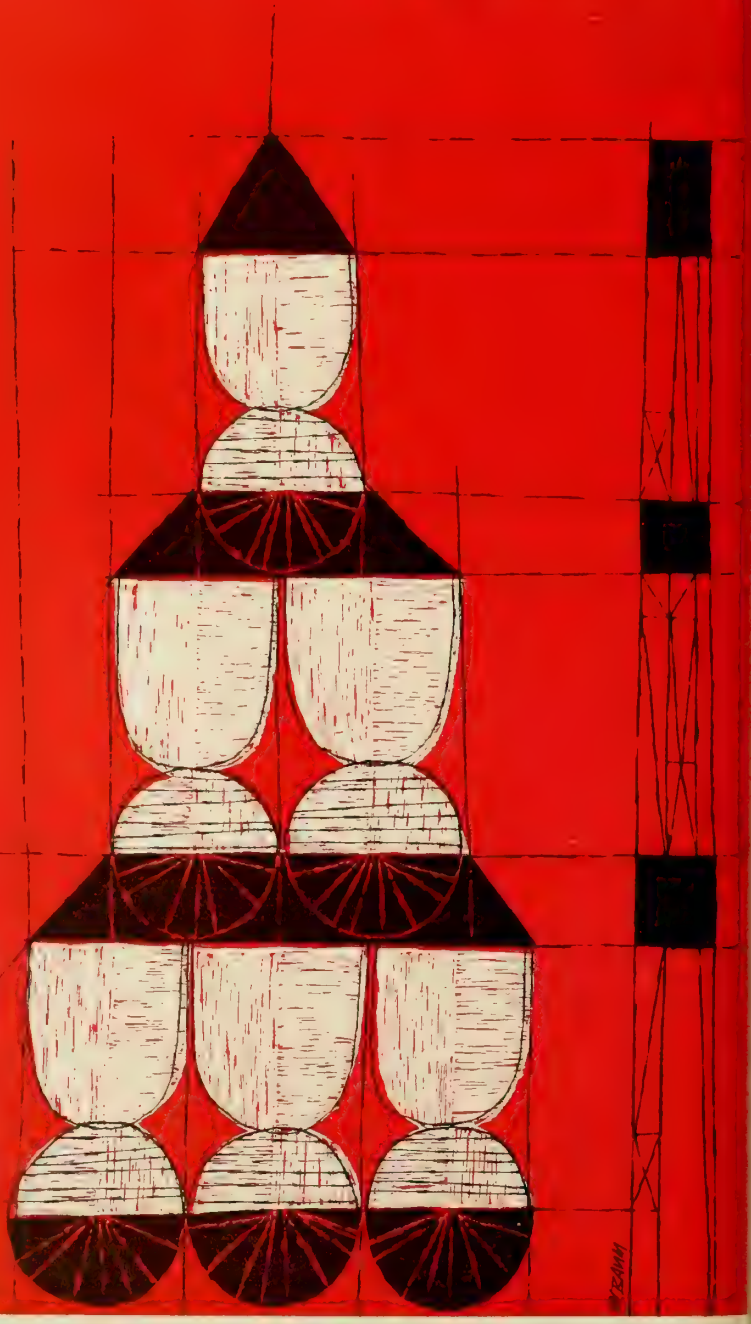
***DISCOVERER XXI** (2100 lbs.) U.S. Launched 2/18/61. Orbits earth; perigee 155, apogee 670, period 97.8. Carried IR equipment for MIDAS program to measure background radiation from earth.

***TRANSIT IIIB** (250 lbs.) U.S. Launched 2/21/61, est. life: weeks. Orbiting earth; perigee 110, apogee 613, period 96.3. LOFTI, 54-lb. piggyback satellite, failed to separate.

*(Orbital data is latest official information as of Feb. 24)*

Advanced programs now in progress at Martin include: vehicle stage weight optimization. The professional mind which is seeking the freedom to inquire will find unusual stimulation, association, and recognition. To participate, write to N. M. Pagan, Director of Technical & Scientific Staffing, (Dept F-1), The Martin Company, P.O. Box 179, Denver 1 Colorado.

MARTIN
DENVER DIVISION



# Cooled Nozzles Developed for Future

***Aerojet-General reports successful testing with metal coolants up to 6500°F and predicts even greater capacity for solids and hybrids yet to come; present programs don't need cooling***

SACRAMENTO, CALIF.—Development of a cooled solid-rocket nozzle for 2000°F operation in exhaust temperatures over 6000°F has been revealed by Aerojet-General Corp.

The simply designed unit uses low-melting metal coolants to achieve the temperature reduction.

Dr. Ernest R. Roberts, assistant manager of Aerojet's solid rocket plant, said the nozzles can cope with 6500°F—plus temperatures expected to result from solid propellants by 1967—and will also be able to handle anticipated hybrid rocket temperatures upwards of 7300°F.

In Aerojet's evaluation of the system, lithium, magnesium and sodium were run through many tests, with the final coolant recommendation depending on factors in the individual rocket under design. Lithium was the most extensively tested.

Weights of the cooled nozzles were equivalent to uncooled nozzles, including the coolant weight. The amount of coolant depends on the temperature and burning time expected in the operation.

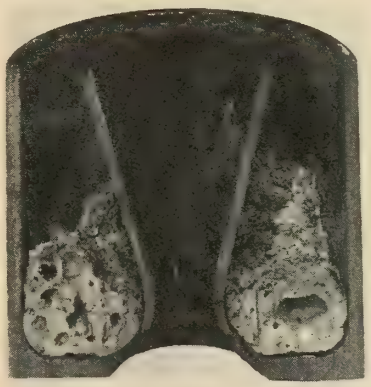
Despite the successful development, Roberts told M/R he sees no immediate application for such a nozzle because the present programs using large solid rockets are progressing well without nozzle cooling. He indicated that there are future applications.

• **Evaporation cooling**—Hundreds of small-scale tests with various configurations and coolants were conducted, resulting in elimination of any system using moving parts. The final configuration was a simple, double-chambered nozzle, with metal coolant behind the walls of the nozzle.

As heat from combustion melts the metal, vents relieve pressure generated by expansion and vaporization, allowing gaseous coolant to escape. Metal coolants perform without the tanks or pumps required by liquid or gaseous coolants.

In a rocket flight involving horizontal attitudes, momentum prevents the coolant from flowing out the vents, although the vaporized coolant will escape.

Each of the three metals tested has a boiling point several hundred degrees lower than the maximum allowable temperature of the planned structural materials for the design.



*COOLED NOZZLE cross-section after 80 seconds at 6200°F. Inner wall is 0.060 in. of molybdenum cooled by magnesium.*



**Evaporation Cooled Nozzle**

Lithium, with the highest heat of vaporization of all the metallic coolants, provides cooling with the least weight penalty. Sodium, with the lowest boiling point of any metallic coolant at any given altitude, results in the coolest nozzle. Magnesium was about halfway between the other two in critical properties.

• **Molybdenum nozzles**—Aereojet engineers also found that once the metallic coolant begins to boil, the temperature distribution on the wall of the nozzle subject to direct rocket blasts remains constant. The firing duration is limited only by the amount of coolant which can be carried without prohibitive weight penalties.

The research program indicated that best results were achieved when the nozzle inner wall is composed of a material of high thermal conductivity, such as molybdenum. Better heat transfer to the coolant is thus obtained.

Additionally, a thin insulation coating applied to the inner throat of the nozzle will reduce the temperature of the surface. Such materials used structural plastics, carbon, carbides, carbon cloth, and other refractories.

There are problems if the nozzle is too cool, Roberts said. If solid particles contained in the propellant (such as aluminum or other additives) change phase during combustion, they will condense on the nozzle wall in event of overcooling. Elimination of additives removes this problem.

Actual tests showed success at durations of 60 to 80 seconds and temperatures of 6200°F. The inner molybdenum wall would ordinarily melt at 4698°F, but wall temperatures were as low as 2000°F.

Lightweight nozzles tested ran for 60 seconds at 6200°F with a two-and-a-half-inch throat diameter, using less than two pounds of coolant during the run. The figure includes 120% excess coolant, the company said.

Aerojet expects to continue the tests in efforts to perfect the nozzle design for much higher temperatures. ⌗

# Cleaning Bares Flaws in Missiles

***Dow Chemical experts report that arduous cleaning process leads to breakdowns and rejections in liquid ICBM's***

**by John F. Judge**

SHODDY WORKMANSHIP in critical missile system components is being revealed through the extraordinary cleaning procedures applied to liquid-fueled missiles.

Defective welds, poor choices of materials and the use of marginal grades within specified steel types are prevalent today—at a time when these ICBM's are combat-ready.

Dow Industrial Service experts, long familiar with the exacting task of meeting government specifications in cleaning liquid oxygen systems and related components, are finding that some items break down in approved chemical cleaning procedures.

LOX equipment is cleaned by etching—the chemical removal of metal. If a part has a heat-sensitized weld area, the etching baths honeycomb the junction instead of removing a uniform layer of metal.

Use of marginal grades in the 304 stainless steel family lead to fatal damage during cleaning. Even the improper choice of welding rods and poor grinding techniques are uncovered in the baths and result in rejected parts.

• **Meeting tough standards**—The cleaning of missiles and launching systems is rigidly prescribed by Air Force specifications. Particles larger than 150 microns are not tolerated, and the complete absence of hydrocarbons and other contaminants incompatible with liquid oxygen is mandatory.

Achieving this exalted condition is another matter. The Dow Industrial Service, division of Dow Chemical Co., maintains 11 stations across the U.S. devoted to missile cleaning. These stations, or "white rooms," are designed to completely clean critical items before they are placed in service. Mobile equipment is employed to clean parts too large for the room or those within the missile itself.

Each cleaning job has its own peculiarities. The equipment used in the process includes vats containing ultrasonic agitators for solvent and acid cleaning; high- and low-pressure demineralized water for rinsing; dry, oil-free nitrogen; infrared drying ovens; vacuum systems; inspection instruments and standard laboratory tools.

The air in the rooms is filtered of particles down to the 3-10 micron range and maintained under slight pressure at all times. Cleaning solutions, water and purge gas are constantly checked.

Personnel enter through air locks and wear specified clothing. For obvious reasons, items in the rooms cannot come in contact with bare skin.

Dow uses various concentrations of nitric-hydrofluoric acids in the pickling baths. Trichloroethylene is used for degreasing operations, primarily because it is LOX-compatible.

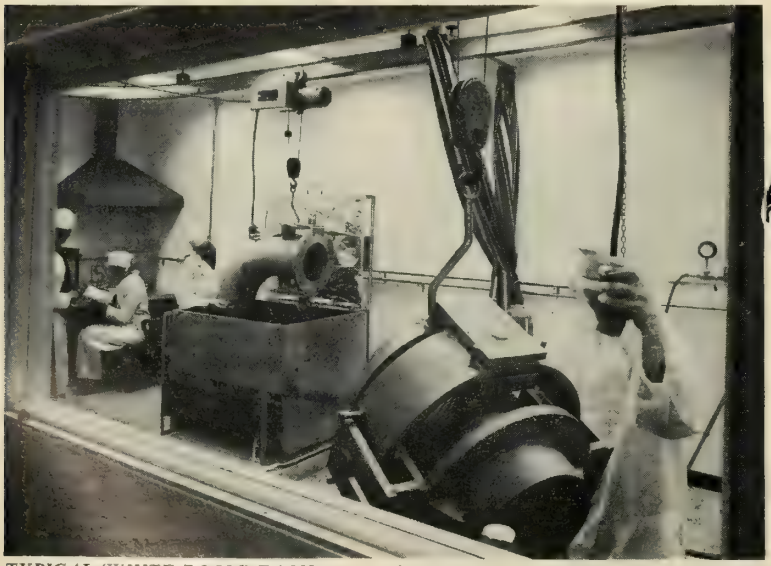
• **Custom tailored methods**—Complex parts generate special techniques. In each case, the procedure fits the problem.

LOX equipment designed into a missile has no spare metal. Consequently, the degree of etching allowed is much less than that accepted for ground support items. If possible, etching is avoided altogether and high-pressure cleaning with water and other solvents is substituted.

Dow experts have developed special foams and foam-forming liquids for cleaning the missile. Bottles, convoluted lines, suction hoses and hydraulic systems have all been successfully cleaned on the spot by Dow teams. Most surfactants are not compatible with LOX but the DIS formulations are free of this complication.

DIS is constantly researching methods and solutions to improve cleaning efficiency and economy. In addition, every new part subjected to cleaning is preceded by data proving that the procedure and materials involved will meet specification limits.

Cleaning operations will be very much a part of the liquid-fueled ICBM launching sites around the U.S. But DIS spokesmen are not aware of any current effort to establish standard operating procedures in maintaining these conditions at operational sites. Even Vandenberg Air Force Base lacks a definite procedure. The absence of such precautions could easily diminish the reliability of our ultimate defense. ‡



*TYPICAL 'WHITE ROOM' FACILITY produces parts that far surpass surgical cleanliness. The slightest speck of oil or grease could easily cause an explosion if it came into contact with liquid oxygen.*

# Surveyor To Collect Wide Range Of Data

***Four television cameras and Hughes-developed soil drill are among variety of scientific instruments designed to conduct four experiments.***

by Frank G. McGuire

PASADENA, CALIF.—The *Surveyor* lunar soft-landing vehicle will carry out four varied experiments in data collection during its scheduled 30-day-plus period of operation.

Jet Propulsion Laboratory, which provides technical direction for the National Aeronautics and Space Administration program, lists the experiments as geophysical, television, lunar soil collection and analysis, and particle and field measurement.

Being developed by Hughes Aircraft Co. for JPL/NASA, *Surveyor* will incorporate more than a dozen scientific instruments.

Included will be acoustical devices, ion gages, magnetometers, a drill, neutron activator, geophysical probe, four TV cameras (one with a filter turret for color spectroscopy), seismometer, particle accelerators, mass spectrometers, and other instrumentation.

In event of malfunctions or vehicle damage during flight or while on the moon, a command signal from the Goldstone Deep Space Instrumentation Facility of JPL will cut certain instruments off the power supply, thus conserving power for more vital experiments.

Experiment requirements for each of the seven planned missions may vary, and Hughes expects to vary payload weights and configurations during the run of the two-year project.

• **Four cameras**—One of the most important facets of the payload will be the television capability included in the Hughes design. Three cameras will be mounted on the vehicle, pointing straight up. A fourth will be mounted pointing downward to view the moon during the approach phase, and later to monitor the drilling operation after touchdown.

For the three upward-looking cameras, mirrors will be located for changing the field of view for each unit. A Hughes spokesman said this is more reliable and easier than rotating the cameras themselves. Zoom lenses will be used to vary the distances covered by each camera.

The four cameras will each use a one-inch vidicon to transmit a 600-by-600-line picture every second. It is believed that this can be reduced in event of a power loss to one 200-by-200-line picture every 20 seconds. The cameras will also be able to look at the spacecraft itself due to the great rotation degree permitted by the mirrors. Precautions will be taken to protect the cameras from damage by direct sunlight and thermal extremes.

A telescope is also under consideration to allow long-distance viewing and also to increase resolution of short-distance viewing. The cameras will be capable of looking back at earth.

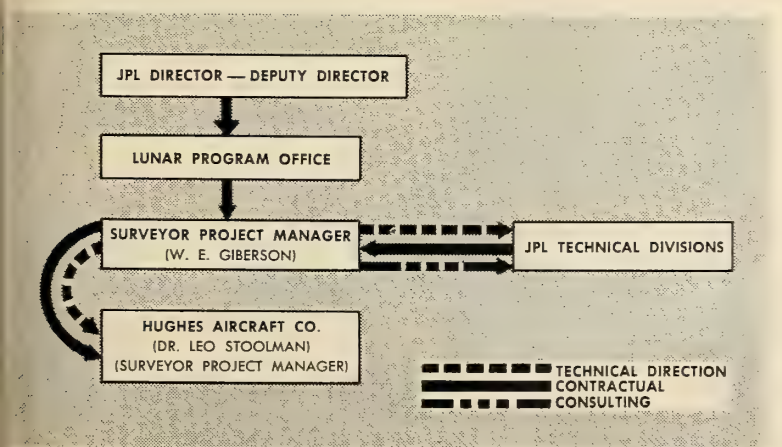
• **Drill rig**—The Hughes-developed drill will use a combination of impact and rotation to break the lunar soil and distribute it to various instruments for analysis. It will probe from 18 inches to five feet below the surface under electrical power. Findings of the analyzing instruments will be telemetered back to earth.

Certain instruments, because of their nature, will be held at "arms length" from the *Surveyor* vehicle on long telescoping booms so that the parent vehicle does not disrupt the measurements to be taken. The 15-ft. booms will hold such instruments as the ionization gage and magnetometer.

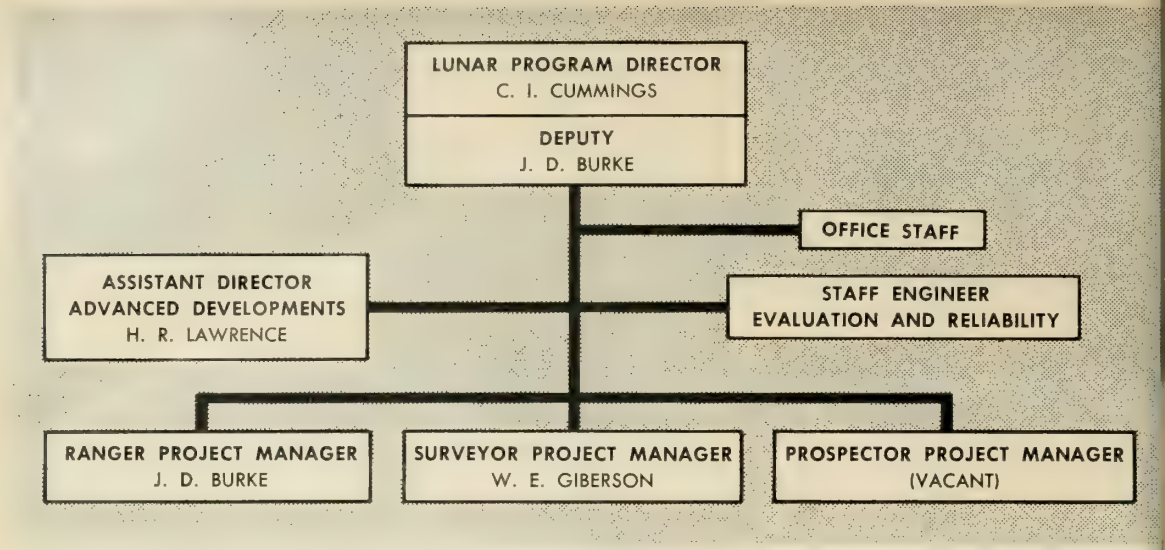
If the *Surveyor* vehicle should tip over upon landing, which is improbable, the data from these boom-borne instruments will likely be lost. But a certain amount of backup is available for other instrumentation.

Power supply will consist of storage batteries and solar cells. The solar array will be about 9 square feet and is expected to operate at a little less than 10% efficiency.

A thermal control system is included in the vehicle to keep the




*JPL/INDUSTRY RELATIONSHIP for Lunar Program Using Surveyor Vehicle.*




*LUNAR PROGRAM OFFICE organizational chart for NASA's Jet Propulsion Laboratory.*

temperature stresses within tolerable limits.

• **By the numbers**—According to JPL, the vehicle's first action on the moon will be to deploy the drill and mass spectrometer. Then it will orient the antenna and solar panel toward earth and the sun, survey the scene with its TV cameras, and deploy instrument booms and other experiments.

A one hour TV survey will be conducted soon after landing; then the cameras will be turned off while other experiments are carried out. A second TV survey will follow.

Instrumentation will be of the command type, supplemented by pre-programed types according to requirements for the experiment.

Surface chemical analysis will be carried out by a X-ray fluorescence spectrometer, a neutron activator, a mass spectrometer and a gas chromatograph for detection of organic molecules.

Surface physical analysis will be conducted by a densitometer, thermal and electrical conductivity instruments, sound speed measurements, and the television systems.

Local subsurface properties to a depth of five feet will consist of X-ray spectrometer and neutron activation instrument in the hole made by the drill, vertical temperature gradient measurements, thermal and electrical conductivity measurements, and the densitometer.

Lunar structure will be examined by a three-axis seismometer and the gravimeter.

• **Ranger bird dogs**—The 11-ft.-tall *Surveyor* vehicle will benefit somewhat from the data to be gained by its predecessor, the *Ranger* probe. *Ranger* will give JPL/NASA an indication of the range of measurement to be expected from each type of experiment, thus avoiding any waste of data because of incorrect calibration.

After injection into its lunar trajectory by the *Atlas-Centaur* fired from Atlantic Missile Range, *Surveyor* will

## Surveyor Experiments

### Surface Chemical Analysis

1. *X-Ray fluorescence spectrometer*
2. *Neutron activation techniques*
3. *Mass spectrometer*
4. *Gas chromatography*

*(Detection of organic molecules)*

### Surface Physical Analysis

1. *Densitometer (λ-Ray Scattering)*
2. *Thermal and electrical conductivity measurements*
3. *Sound speed measurements*
4. *Vidicon with variety of magnifications*

### Local Sub-Surface Properties (Drill to 4 or 5 Feet)

1. *X-Ray spectrometer and neutron activation instrument in cave-hole*
2. *Vertical temperature gradient measurement*
3. *Thermal and electrical conductivity measurements*
4. *Densitometer*

### Structure

1. *Three-axis seismometer*
2. *Gravimeter*

weigh about 2500 lbs. Landed on the moon, the vehicle will weigh about 750 lbs., of which 500 lbs. will be communication equipment, structure and temperature control devices.

Contractually, JPL/NASA will handle *Surveyor* in a way different from its approach to the *Ranger* system. In *Ranger*, JPL is designing, assembling and operating the spacecraft, while using some minor subcontracts and one major subsystem contract. Aeronutronic will build the *Ranger* lunar capsule for JPL.

In *Surveyor*, however, the complete spacecraft system design and operation responsibility is being turned over to Hughes Aircraft Co. JPL will retain execution of missions including general project control, solution of interface problems, and coordination of scientific experiments from various sources.

The program beyond *Surveyor* to *Prospector*, will be handled in about the same manner. *Prospector*, a moving vehicle for lunar exploration, will be designed as much as possible to use proven hardware and techniques tested in the two preceding lunar programs.

JPL says that it may be necessary to develop a new means of locomotion for *Prospector*, as well as some special components, but that essentially the vehicle will be based on hard knowledge, rather than a list of inventions.

Funded, competitive industry studies will begin in Fiscal 1962, and JPL expects to notify industry when activity begins on *Prospector*.

In *Surveyor*, as well as *Prospector*, program management will be carried out by the project manager monitoring the prime contract, with technical assistance from the JPL technical divisions. ‡



gineering and manufacturing AMF has ingenuity you can use....

# He's got Minutemen "working on the railroad"

Hard basing is one way to protect America's force of retaliatory ICBM's. The problem was to find an alternate means of accomplishing the same mission. The Air Force solution was a new ICBM mobility concept—railroad car-mounted Minutemen, utilizing the nation's vast track mileage for numerical and geographical dispersion, creating a difficult target for enemy attack.

To put the Minuteman, its support systems and associated equipment on rails was a completely new problem in missile handling. The first requirement assigned by Boeing to American Machine & Foundry Company and ACF Industries, Inc., was a feasibility study of the existing limitations of roadbeds, rails, railroad operations and right-of-way. Unique tactical cars are being designed within these limitations to carry the Minuteman—cars that can handle the missile and its operating equipment, safely isolated from roadbed shock and ready for immediate retaliatory launching.

### Single Command Concept

Whether for conceptual problems such as this one, or for challenges in design or manufacturing, AMF has ingenuity you can use. AMF people are organized in a single operational unit offering a wide range of engineering and production capability. Its purpose—to accept assignments at any stage from concept through development, to production, and service training...and to complete them faster in

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# How Can Pilot Best Control Ship's Attitude?

***Study by Lear, Inc. tests six configurations in simulation booth to determine what degree of manned control is best, which equipment is suitable and what is lacking.***

by Charles D. LaFond



*SIMULATION BOOTH developed by Lear, Inc. was used to study attitude control in "manned space vehicles." View shows location of displays and right and left control consoles. Analog computer was used to provide simulated system dynamics.*

THE PILOT of a spacecraft will be able to stop vehicle spin with reaction jets in 10 seconds. He'll do it with 90% efficiency in fuel use, if he has the proper displays and controls.

Lear, Inc., in a report recently presented to the Air Force, disclosed these findings from an exploratory study of "Manual Attitude Control in Space." The study is part of an overall research program, performed by Lear under an AF Flight Control Laboratory contract during the past several years, to investigate and develop cockpit and control/display requirements for manned space vehicles (M/R, Aug 8, 1960, p. 36).

When, in the not too distant future, man flies in outer space—whether in an orbiting boost glider, aerospace plane or an interplanetary space ship—there will be many functions that he must perform or at least monitor. One of these—with certainty—will be the control of vehicle attitude.

It will be needed for antenna orientation, environmental control, maneuvering, weapons launch, navigation and observation. And especially during the unpowered portion of the flight.

To this end the present phase of the contract work is directed—to find out how attitude control will be performed, when, how well, in what time period and with what instrumentation and fuel requirements. An equally important goal is to find needs for equipment or instrumentation not yet available and to determine requirements for their eventual development.

Finally, the researchers are attempting to learn which attitude control is best: manual, fully automatic or some combination. If a combination appears best, the extent of each and override limits must be determined.

• **Six approaches**—A simulation booth, with necessary controls and displays, was employed in the experiments. Outside, an analog computer was used to provide system dynamics and a means for scoring.

The 3x5x5-ft. high booth also was provided with two-way communications. Controls and foot pedals were modified and relocated when necessary during the various tests.

Six different control configurations were examined by the researchers. Three made use of a hemispherical control knob permitting three-axis motion. A modified autopilot controller, the knob permitted both an on-off capability and a three-direction variable control—output proportional to the angular deflection. It also was spring loaded for automatic return to neutral (center) on each axis.

Of these three control configurations, two differed only in the location of the knob: one was installed on the

console to the right of the operator; the other was mounted on an armrest just above the operator's lap. With either approach, control was possible simply by wrist motion, but the armrest permitted adjustment of the unit for maximum comfort.

In the third approach, the yaw control was disconnected and tied into two foot pedals in front of the operator.

The fourth and fifth configurations employed a different controller, provided with three separate controls. Disc shaped, each was mounted on the same panel in such a way that it could be rotated about the axis corresponding to its control function—yaw, pitch, or roll. Only on-off action was provided.

Interchangeable with the hemispherical knob, the controller was installed on the right console in the fourth experiment and the foot pedals again were used for yaw control in the fifth approach.

Single disc-type controls and the foot pedals were used in the sixth control configuration. Pitch control was installed on the console to the right of the operator and roll was handled from his left. These controls too were capable only of on-off action and were spring loaded for return to neutral.

Two display configurations were examined; both employed a standard Lear moving-sphere, three-axis, attitude indicator. Modified slightly (moving bank-angle indices on the periphery of the display were masked), it showed elevation, azimuth, and roll angles continuously through all possible attitudes.

The moving-sphere indicator was used alone on the first tests; three meter-movement indicators were added for the next display configuration. These displayed angular rates for yaw, pitch and roll in degrees/second. Standard Simpson panel meters were employed having zero rate at the centers and five graduations on either side of the zero index.

• **Simulations: realistic, diversified**—Two hypothetical space vehicles were assumed in the project, one spherical with equal moments of inertia around all axes; the other non-spherical with unequal moments. Pitch and yaw moments of inertia were determined at ten times the roll value, in the latter vehicle.

As mentioned earlier, system dynamics were simulated with an analog computer. Completely undamped attitude control was provided by simulating a pair of opposing reaction jets in each of three orthogonal planes referenced to the operator's position. To simulate the lag of a typical attitude control system, controller outputs were passed through a 0.25-sec. time lag.


MODULAR TELEMETRY RECEIVER FEATURES MULTIPLE BANDWIDTH SELECTION



The CENTAUR Receiver used by NASA

Nems-Clarke Model 1455

Designed to provide a selectable bandwidth capability for PCM, the 1455 most nearly approximates a "universal" telemetry receiver. IF/Demodulator Modules are available in bandwidths ranging from 100 KC to 1.5 MC. Each module contains 3 independent demodulators. Selectable by a front panel switch, they are: Foster-Seeley Discriminator, Phase-Lock Detector, and AM envelope detector. As a further refinement in signal-to-noise ratio enhancement, the video amplifier incorporates a video bandwidth filter having a 6 db per octave roll-off adjustable from 20 KC to 1.2 MC by means of a front panel switch. This receiver is capable of **optimum** reception of any known type of telemetry signal. Features: 5 MC pre-detection recording output, playback input terminals, and integral VFO, automatically actuated by a micro-switch on the crystal socket. The modulation sensitivity and deviation meter scales provide output voltages and meter deflections which are essentially the same percentage of bandwidth in all modules.

Available as an accessory unit is the Nems-Clarke IFC 1400 Pre-Detection Converter which permits use of the 1455 with stationary-head instrumentation tape recorders for pre-detection recording.

See the 1455 Receiver at the I.R.E. Show, Booths 3917-3919.

Vitro ELECTRONICS A DIVISION OF VITRO CORPORATION OF AMERICA
PRODUCERS OF NEMS-CLARKE EQUIPMENT
919 JESUP-BLAIR DRIVE, SILVER SPRING, MARYLAND / 2301 PONTIUS AVENUE, LOS ANGELES 64, CALIFORNIA

Outputs were integrated to obtain the three body-axis rates, which were then used to position two servo-multiplier shafts for each axis. The multipliers used with integrators and summing amplifiers generated direction cosines.

With such a setup, a variety of possible experimental conditions were available; as many as practicable were used in the tests. In the static state, four different initial attitude positions were available. Selection was by a switch before the start of the particular experiment.

Any of twelve combinations of body axis rates could be preset before the trial began. When the dynamic condition was specified, two initial situations were possible; either the trial commenced with vehicle spin starting from 0°, 0°, 0° position, or the vehicle was permitted to spin for 10 sec. and attitude information was presented to the operator.

Two control systems were available: in one, the reaction jets were either fully on or fully off; in the other, thrust magnitude of the reaction jet increased as a linear function of the amount of control deflection.

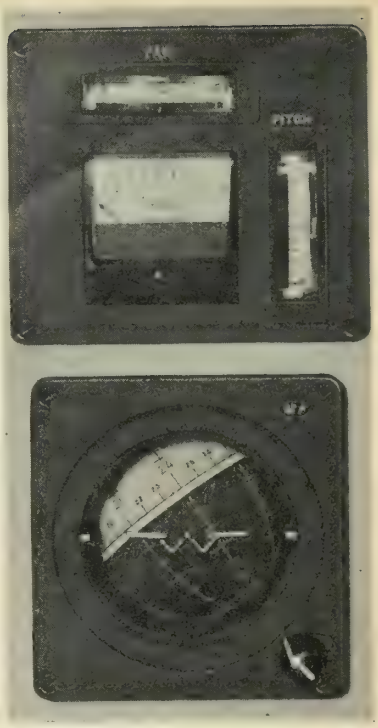
In scoring, operator performance was indicated by measuring the amounts of control action and time required to accomplish a specified task.

Male test subjects, ranging in age from 25 to 40 years were used in the simulations. Previous flying experience varied from current-jet-aircraft-operation down to no-pilot-training for six Lear personnel. Several had previous experience with aircraft simulators.

Regardless of their backgrounds, test subjects were thoroughly familiarized with the simulator and its controls by means of tape-recorded briefings, demonstrations, and a minimum of three 40-minute practice sessions each. Also, test subjects were given time to practice before each experiment, following the briefing for that test.

Twelve experiments were performed in all by each participant. An orderly variance was achieved in the twelve tests by the choice of simulated vehicle configuration and its initial position and condition, controls and display selection, and the assigned task. In all, thirty-five test conditions were achieved in the twelve experiments. Obviously more could have been obtained, but these were considered most meaningful and representative. Also, several tests were identical. This was done to check the effect of learning on the test results.

• **Control is feasible**—Lear feels that this first, not too precise, set of experiments has shown the feasibility of manually controlled attitude of space vehicles. Further, it has shown that with rate displays subjects were able to



*METER-MOVEMENT angular-rate indicators (above) and moving-sphere three-axis attitude indicator (below) comprised the display configurations examined during the twelve simulations.*

stop spins in roughly 10 seconds with a fuel-use efficiency of approximately 90%.

But most of all this was a beginning. It has laid the groundwork for future study and has revealed the various avenues to be explored.

For example, test results indicate that the attitude displays accounted for the largest equipment effects. For the future, it is believed that more intensive investigations of display variables could provide the best payoff for the variables tested. Better displays may result from a better understanding of the contribution proffered by these components.

Another point. The issue of proportional vs. on-off controls was only slightly cleared by the limited tests. On-off controls seem to offer a small time advantage, but a slight fuel advantage resulted from the use of proportional controls. A more concentrated effort will help determine the range for each by employing more precise measurement techniques. At the present time fuel appears to be an extremely critical problem in orbit, thus even a small increase in utilization efficiency could prove to be rewarding.

Insignificant gains were revealed with the interchange of controllers and their location. However, Lear feels that only good configurations were employed, with selection based on prove apparatus and physiological necessity This does not mean that different control-display relationships might achieve significant improvements.

• **More answers urgent**—Only th surface has been scratched in this que for critical knowledge. The Air Forc is expected to award a follow-on cor tract for this research sometime i March. Besides those more advance studies already suggested, other invest gations are indicated in the Lear finc ings:

(1) The inputs to more sophisticate control systems should be studied. Ra indicators may be eliminated by alloca ing the integrations needed to the cor trol system itself. (It was also suggeste that a reaction jet which could b moved relative to the vehicle surfac might increase efficiency simply b offering better alignment with the r sultant motion.)

(2) Display and control design s far has been studied with respect to a titude maneuver for the control of spi There may be other influences not s far considered which could alter equip ment configurations.

(3) An alternative approach t minimum fuel consumption should b considered. Orbiting space pilots, fc example, may prefer working with lo rates of change and take a long tim to perform a control task. This woul significantly increase demands for dis play and control sensitivities.

(4) An intensive study of the cor trol-display aspects and the informa tion requirements for re-entry are mar datory.

If the present studies are continue to their logical conclusion, man in controllable space vehicle will have th best that can be designed under ou present earthbound developmental lim itations. Advanced modifications, base on practical experience, still will hav to come from those who have live through such flights and returned.

# UDMH 'Tagged'

## Tracerlab Development Locates It in Bodies

ONE OF THE MOST toxic pr pellants handled by man has been give a "tag" so that physicians can trac and control its effects on those wh must be exposed to it.

Tracerlab of Waltham, Mass., h completed a WADD contract for syn thesizing Unsymmetrical Dimetheyl Hy drazine (UDMH) with a small amoun of radioactive Carbon 14. Exper menters will thus be able to identif the compound in the user's body an gather data on its metabolic fate.

# XLR99

Most powerful rocket engine ever built to the strict reliability specifications needed for manned flight...and now powering the X-15 on its record-breaking missions to the fringes of space... the pilot safe, pilot controlled XLR99 is adaptable to many aerospace programs planned for the future.

# THIOKOL

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Rocket Operations Center: Ogden, Utah. Reaction Motors Division built XLR99

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# AEC Funding Cut Hits SNAP 4 Underse

***Space power units are now getting top priority; Navy cannot show requirement***

by William Beller

MONEY PROBLEMS are snagging development of SNAP 4—a 3-megawatt nuclear powerplant holding a possible high potential in antisubmarine warfare.

The Atomic Energy Commission, MISSILES AND ROCKETS has learned, is lopping $1 million from the program, reducing SNAP 4 to $600,000 in FY '62.

The cutback results from lack of a hard and fast requirement, plus DOD and NASA requests to step up development of SNAP units 10A and 8 for use in space. AEC reportedly took the $1 million from SNAP 4 when it had to find $9 million to finance the acceleration for the other two programs.

SNAP 4 appears to have run into a long-standing hassle between DOD and AEC over the AEC's demand for "specific" requirements. The policy was set forth rather pungently by former AEC Chairman John A. McCone, who had a habit of telling the military: "Now look, damn it, if you want it, say so. But, by God, if I build it for you, you better use it."

Lack of a user requirement for the 17-ton terrestrial and underwater SNAP 4 reactor was disclosed Feb. 23 during a hearing by the Joint Congressional Committee on Atomic Energy.

• **Wide ASW uses**—The hearings brought out that the SNAP 4 was stimulated by an attempt to get a powerplant small enough to be used at the bottom of the ocean and be left unattended for a year.

Dr. Chauncey Starr, president of Atomics International, prime contractor for reactor nuclear systems for auxiliary power, told the Committee that SNAP 4 could be ready for ground-testing in 1965. It could develop from one to three megawatts of electrical power; and would consist of a nuclear reacto and a power conversion unit to chang the heat of the reactor into electricity

There are many uses seen for suc a unit. It conceivably could generat enough power to keep several hundre thousand square miles of ocean are under constant surveillance for a yea by a network of active sonobuoys; c an area many times that size for a indefinite period by a network of pa sive sonobuoys.

For marine applications, two SNA 4 units connected in parallel would giv out 6000 shaft horsepower. This woul be enough to drive the relatively sma and cheap nuclear submarines tha some Navy planners say they wan The conventional nuclear submarin needs 15,000 shaft horsepower an costs about $55-million.

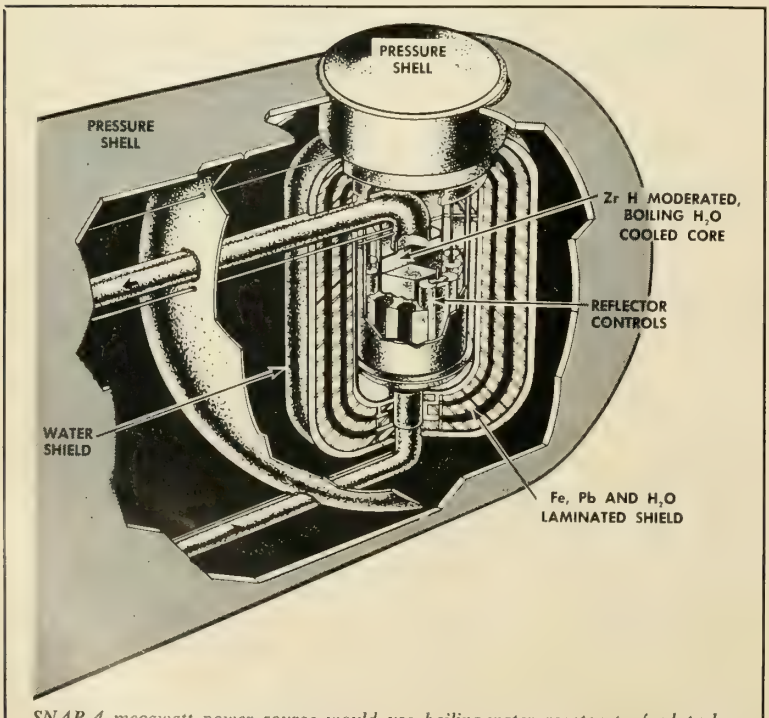
Some military observers are wonde ing at DOD's lack of imagination re garding SNAP 4, especially since n other power source even competitiv with it is on the horizon. For exampl they see versions of SNAP 4 being i stalled on torpedoes which could b strategically placed and poised for a attack.

They also see SNAP 4 being use as sustaining power in the hydrofo fleet the Bureau of Ships is now co templating; and for powering ocean floor reconnaissance vehicles such a the ones being developed by Hughe Aircraft and Cook Electric.

These vehicles are expected t search the ocean floor for enemy mine sonobuoys and other foreign bodie Some of them will have a televisio camera helping. If nuclear-powere they would be independent of cable an batteries, could be directed by son signals or, if a float is sent up, by radi signals from aircraft or ship.

SNAP 4 could also be used as a emergency power supply, or as an ai transportable energy source for remo areas. It could also be barge-mounte for some industrial power needs.

• **A power play**—The AEC's polic of "no specific military requiremen no money," was sharply criticized la December by the Joint Committe on Atomic Energy chairman, Repr sentative Chet Holifield. He said, " would seem to me that the AEC shoul proceed independent of a requireme from another agency if the research an development appears necessary an desirable."




*SNAP 4 megawatt power source would use boiling-water reactor to feed turbo-generator. Typical 17-ton unit would be contained in 16-ft.-long cylinder.*

# ower Unit

Pointing a finger at DOD, Holifield observed during the hearings now going on that; "If this Committee and the AEC had stood back and waited for the Navy to make a requirement for a nuclear-powered submarine, we would not have it yet . . ."

In the present situation, the SNAP 4 program appears to be both a pawn in a struggle between DOD and the AEC concerning the requirements question; and at the same time, a wedge to force Congress to give more money to the SNAP 4 program. The importance of the project is considered high enough to bring both issues to a head.

A critic remarked during the present hearings that if nothing is done, a few years from now this Committee will be able to look back and pinpoint 1961 as the start of the "ASW Gap."

• **SNAP 4 today**—Right now, SNAP 4 is in its preliminary design stages. Next portion of the program, if it moves ahead, will be a critical experiment at the end of the year.

The turboelectric converter work has been studied in a preliminary way by several manufacturers; however, Atomics International has not yet authorized any work on it.

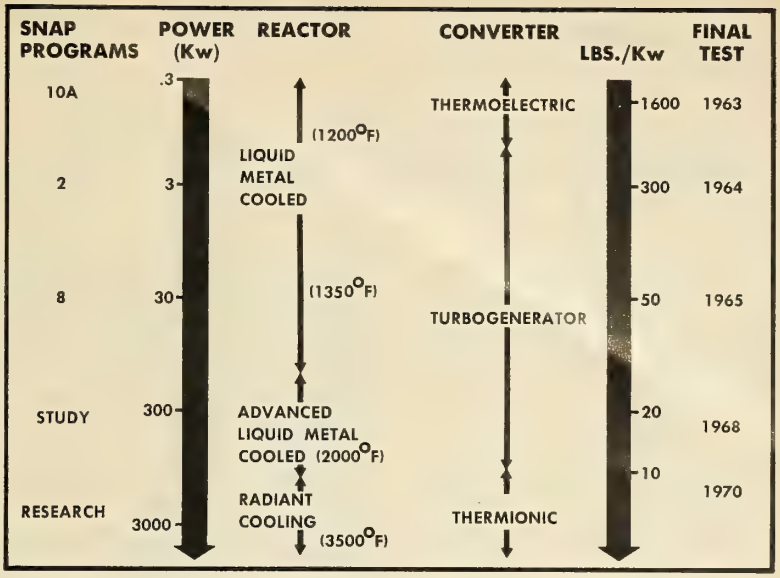
Starr said that if the SNAP 4 program is given significant support, "We would have ground test availability toward the end of calendar 1965."

• **How it works**—The SNAP 4 concept uses the conventional steam powerplant cycle—the Rankine cycle—to generate electricity. However, in the SNAP unit the heat source is in the nuclear reactor. The nuclear fuel turns the coolant water into steam, which in turn drives a compact turbogenerator.

This combination of a compact reactor and power conversion system is said to lead to a transportable, factory assembled and tested terrestrial power unit.

The SNAP 4 reactor departs from the usual boiling water reactor (BWR), where neutron moderation is done by the hydrogen in the water. In the SNAP 4, about 70% of the neutron moderation is performed by the hydrogen in the hydride fuel element.

Because of this technical difference, Atomics International reports that the power density in the SNAP 4 reactor would be six to ten times as great as that in a conventional BWR. This means that for equal power output, the SNAP 4 core volume would be only one-sixth to one-tenth that of the usual BWR.




*TEST DATA and characteristics for space-oriented reactor-type SNAP units.*

A typical SNAP 4 unit would weigh about 17 tons. It would be contained in a cylinder about 16 feet long and 7 feet in diameter. Illustrative of the extreme compactness of SNAP 4 is that the weight of only the containment vessel to resist a 6000-fathom water pressure would be twice that of the powerplant itself.

In a marine application, the SNAP 4 would be developing power at about 40 pounds per shaft-horsepower. This is the same as the machinery weight per shaft-horsepower for high-powered naval vessels such as cruisers, fitted with modern geared turbines.

• **Other SNAP programs**—Except for SNAP 4, the SNAP systems being developed are designed to give power chiefly under a space environment.

These sources range from a few watts of electrical power to 60 kilowatts. The power range from a few watts to several hundred is generated by units whose heat comes from the decay of radioisotopes. However, above several hundred watts, the radioisotope gives way to the nuclear reactor.

The present SNAP reactor programs for outer space applications are SNAP 10A, a 500-watt power unit; SNAP 2, a 3-kilowatt unit; and SNAP 8, a 30- to 60-kilowatt unit. For inner space or terrestrial use, the SNAP 4 program covers the power range from 1- to 3-megawatts.

An accompanying chart shows the status of the various SNAP reactor programs. SNAP 10A involves a thermoelectric converter with no moving parts. On the other hand, SNAP 2 uses a compact mercury-vapor turbogenerator as its energy converter.

The SNAP 8 reactor is a slightly enlarged version of the SNAP 2 in order to give the higher power. Thus, the SNAP 4 reactor would be able to build on the basic fuel development and control concepts of the other SNAP systems. ⌘

## Navy's Giant X-Ray Ready For Big Booster Inspection

A TEN-MILLION-VOLT X-ray inspection unit will be probing *Polaris, Minuteman* and *Skybolt* solid motors for flaws, cracks and voids at the U.S. Naval Ammunition Depot, Concord, Calif.

The radiographic linear accelerator was designed, built and installed by Varian Associates, Palo Alto, Calif. The X-ray head can be rotated 360° in a vertical plane. The linac is mounted on a turntable which rotates 360° in a horizontal plane and is suspended from a telescoping crane.

A powerful electron gun bombards a gold target which emits X-rays so powerful they can radiograph a five-foot-thick section of fuel in a matter of minutes.

Flaws down to a few hundredths of an inch in diameter can be detected on the films produced by the instrument.

Shakedown tests have been completed and the new machine is ready for production operation. The Depot has two two-million-volt inspection units and the large Varian Linac will reduce the time and cost of inspecting large motors to approximately a fourth of that required for these units. ⌘

# NATO Spurs French Range Expansion

by Bernard Poirier

THE FRENCH are planning to extend their African missile range by some 2000 miles, making it the West's longest overland range in the Northern Hemisphere.

This range, together with others proposed, would enable France to step up its present firing rate of about 30 missiles a week from Colomb-Béchar in Algeria. New ranges would extend in different directions from the same area.

New construction of launching, storage and telemetering facilities has already been authorized. SETEL has selected this site for NATO *Hawk* evaluation and assurance flight tests.

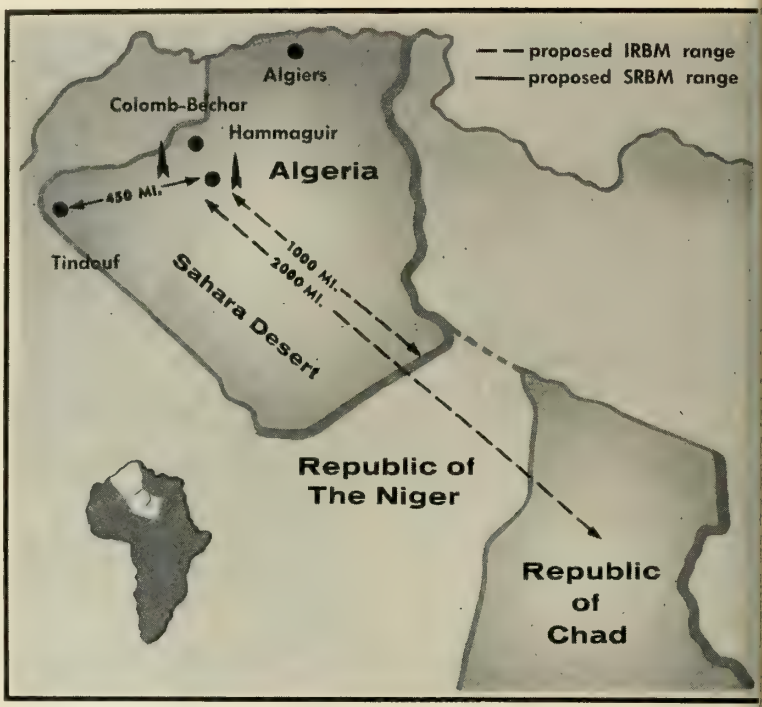
Colomb-Béchar is usually identified as the major French missile test center, but the actual center of activity is Air Force Base No. 145, located nearby. An 80-square-mile range just northeast of No. 145, Range B-1, is used for air-to-air and air-to-surface tests. It is close to the Moroccan border in rugged, uninhabited terrain. Larger vehicles are usually launched 70 miles southwest. It is at Hammaguir that French scientists pin their hopes for serviceable SRBM and IRBM ranges.

It has been found that spent vehicles and instrumented packages can be recovered quite simply and reliably on the adjoining empty plateau.

• **Expansion plans**—So far, the operating area has been confined to a strip 60 miles by 35 miles. Current plans would extend one arm of the range 450 miles southwest towards Tindouf and the Mauritanian border. Another firing corridor, southeast, would extend close to 2000 miles—from Hammaguir, over Algeria and Niger, to the midlands of Chad, once part of French Equatorial Africa.

Expansion of electronic measuring and tracking inventory is being undertaken. Much of the existing equipment, such as Cotal radar, is mobile and most of the aprons accommodate mobile launchers and peripheral units.

Technical management of all Algerian missile operations is provided by C.I.E.E.S., Le Centre Interarmées d'Essais d'Engins Spéciaux. The Army plays the most important role, followed closely by the Air Force. While the Navy does have representation, it has its own test site on Levant Island.




*FRENCH PLANS TO EXTEND missile range to Republic of Chad could run int difficulty if there are objections from neighboring Republic of the Niger, whose terr tory would be overflown. Expansion would require additional tracking stations.*

Representatives of the nationalized military propellant industry and C.N. E.T. (National Bureau for Communications) are stationed there. So are many civilian technicians from organizations like DEFA, makers of the *Véronique* and *Parca*.

Despite excellent air transport routes, however, autonomous operations are hampered because the useable computers are located in France proper. For instance, telemetering data is collected on rapid magnetic tape, at the rate of 1050 bits per second, and the tapes are then sent to Bretigny for deciphering and analysis.

• **Speed-up coming**—The French will soon step up action in response to NATO interest The base reports that NATO's *Hawk* prime, SETEL (Société Européenne de Téléguidage) has already initiated administrative and engineering activities through personnel of Thomson-Houston Co. of France.

Moreover, missile capabilities of the new Mirage III and Mirage IV strike force aircraft (M/R, Feb. 6, p 40) will be proven here. Expansio plans are also necessary to accommo date the *Super-Véronique* and anothe research rocket being manufactured b Sud-Aviation. Other missiles, includin the advanced *Parca* version, requir longer working areas.

New tracking stations will have t be installed well beyond those at Post 22 and at Beni Abbès.

The whole North African range ha two important natural advantages. Aric flat and mostly uninhabited land assure security. Secondly, the very dry ai facilitates accurate optical tracking op erations.

From the first launching in Decem ber, 1949, the number of firings in creased to 800 in 1958 and to 125 the following year. Approximatel 5000 persons are stationed or employe at the various complexes which com prise the Colomb-Béchar establishmen In addition, the French Army main tains two full strength missile weapon units in training at all time.

## Booster Breakthrough?

(Continued from Page 13)

If the big solid were substituted for *Saturn* as a booster, some additional money would be involved, of course, to build a vehicle around it. The latter money need not be spent, unless it becomes apparent that *Saturn* is slipping badly. The big liquid-propelled rocket is due for flight test with three live stages in 1963. First operational *Saturn* is to be launched in late 1964 or 1965.

The more likely application would be as propulsion unit for the *Nova* vehicle. Whatever form of propulsion is used for the manned lunar flight, there is high probability there will be need for a big booster, built by clustering several engines of F-1 size.

• **High thrust**—A solid rocket, which normally does not burn more than 60 or 70 seconds, would have almost twice the takeoff thrust of *Saturn* or F-1 in doing the same work. Thrust would be in the range of 2½ to 3 million lbs. However, if burning time were just half of the *Saturn* booster's 128 seconds, the solid rocket would not have to quite double *Saturn's* 1½ million lbs. thrust.

The reason for the latter saving is the advantage of the high-thrust solid in gravity loss. A big liquid weighing about 1 million lbs., which takes off with 1½ million lbs. thrust, has a net upward force of about ½g. This gradually increases, of course, as propellant is consumed. The solid, with takeoff thrust of almost 3 million lbs., has a net upward force of almost 2g.

The net force of the solid motor also increases gradually until, at burnout, its net force is about the same as the burnout force of the 1½-million-lb.-thrust liquid booster. Thus it is clear the solid has lost less to gravity than the low-thrust liquid, even though both have the same total impulse.

Industry groups have been working for both the National Aeronautics and Space Administration and the Air Force on study and feasibility contracts in the area of big solid boosters since 1959. Currently, the Air Force has a program under way with Aerojet-General Corp. and NASA has just completed one with United Technology Corp. In addition, NASA studies are nearing completion at Aerojet, Thiokol and Grand Central Rocket Co.

Top Air Force R&D officials have indicated they believe one more interim step is necessary before a big solid rocket is built. NASA Deputy Administrator Hugh L. Dryden voiced somewhat similar views before the House Space Committee last month when he said a big solid could never be developed in time to compete with *Saturn*.

The NASA program calls for building a single segment weighing about 60,000 or 70,000 lbs. in the next year, as a demonstration that solids have "come of age." None of the technical people believe the 60,000-lbs. segment development is necessary for technical reasons.

• **Feasible now**—Skipping the 60,000-lb.-segment interim step would save a year of time. It would also save the cost—estimated at about $3 million—of developing and testing the segment. It would require, however, an immediate appropriation of $10 million.

William Cohen, NASA chief of solid rockets, reports that studies near completion by Aerojet, Grand Central and Thiokol all conclude that a big booster of 180 million pound-seconds impulse is feasible now. All find that the rocket can be built with existing propellants and inert materials. "The greater size will be the only extension of the state of the art," he said.

Cohen, who was chief propulsion engineer on the Navy's *Polaris* program from its start until about six months ago, said he is convinced that the big rocket can be developed in 30 months' time. He estimated that development can be completed with 7 to 10 full static firings.

The three NASA studies, with total cost of $225,000, covered solid boosters for two missions—the approximate *Saturn* mission of 40,000 lbs. to a 300-mile orbit and the manned lunar mission of 120,000 lbs. to escape velocity. Aerojet is studying both missions while Grand Central is working on the smaller one and Thiokol on the bigger one.

For the smaller motor, Cohen said, the consensus is a stage weighing about ½ million lbs., from 60 to 70 ft. long, with a diameter of 12 to 14 feet. If the segmented approach is used, he said, individual segments would weigh about 100,000 lbs.

The first step in the development program would be to build a single segment of about 100,000 lbs., to test physical and ballistic properties and insulation. When the segment is proved out, several segments then would be put together and fired to test the nozzle and vector control system.

If a major R&D program on a solid motor were started, Cohen said, it would be directed by NASA's Marshall Space Flight Center at Huntsville, Ala. "They have a world of propulsion skill," he remarked.

He said liquid upper stages are contemplated for any launch vehicles based on solid boosters. However, the upper stages designed for *Saturn* could not be adapted to a solid booster without modification. Tankage would have to be increased to provide longer burning time. ⌗

## Dyna-Soar 3rd Stage

(Continued from Page 12)

third stage independently of the rest of the system, and be carried to an altitude sufficient for him to take over aerodynamic control of the craft and either crash-land or eject from the vehicle.

Reports indicate a glass case has the inside track with Boeing, partly due to the success of the third stage *Minuteman* case. Glass has been proposed as case material by at least two bidders, Rocketdyne and Hercules, and possibly Allison Division of General Motors, which would supply cases to another contractor for propellant loading.

If it were not for the weight consideration, one source said, the present second stage of *Minuteman* would be modified. If a metal case is chosen for the final item, weight saving steps may be taken which are not now standard in the *Minuteman* configuration. These would include modification of the aft dome configuration, closure bolting flanges, and other inert parts.

The nozzles themselves will not be the same as those on *Minuteman*. Volume capacity of the motor is about 72,000 cubic inches, in a case between three and four feet diameter by slightly less than five feet long. Wall thickness of the case may vary, depending on the successful bidder and case material chosen.

An informed source said it is unlikely a titanium case will be chosen, because "Boeing doesn't want to gamble," and it is not as light as glass.

• **Glass problems**—The propellant will very likely differ from that used in *Minuteman*, and will have to be capable of withstanding considerable temperature variation to perform successfully from sea level to extreme altitudes. Use of a glass case also demands propellant flexibility, because glass stretches three times as much as steel under combustion pressures.

Those contractors planning to use glass feel that a pre-impregnated glass roving presents the best approach. Glass cases proposed incorporate the largest ratio of end openings ever fabricated for stress levels over 100,000 psi. A 70% opening is specified for the large nozzle end of the case, while the forward end has an "extremely small" opening. Nozzles will use attachments, rather than being integrally wound into the case. ⌗

RUSSIA'S ROCKETS AND MISSILES. Dr. Albert Parry. Doubleday & Co., Inc., Garden City, N.Y. 382 pp., $4.95.

In the late 1940's Leslie C. Stevens, the U.S. Naval Attaché in Moscow, read and marveled at the 10th edition of a Soviet book that belonged to the space-prophet school of literature. The book was more than 15 years old.

"Interplanetary travel is just the thing to catch the Russian imagination," Stevens wrote. "There is an excellent chance that the Russian engineers, who do not lack for brains, will pioneer in this field."

Dr. Albert Parry, professor of Russian studies at Colgate University and a noted student of Soviet scientific affairs, recalls Stevens' words in his highly penetrating and fascinating survey of Russian efforts in the missile and space field. He begins before the days of Peter the Great in the 17th Century. He naturally ends with the great Soviet *Sputniks*. Along the way, he presents one of the most incisive explanations of how the Russian rocketry accomplished its astonishing successes.

The first Russian writing on war rockets has been traced to 1607, about the time of the first English settlement at Jamestown. A master of gunnery named Onisim Mikhailov proposed the development of rockets that would be "cannon balls that run and fly."

From Mikhailov, Parry traces the works and frustrations of Russian rocket pioneers to Tsiolkovsky in the 19th and 20th Century, to the great brain-picking of German rocket experts immediately after World War II, to the present day. He also digs deeper, probing the Soviet psyche.

At one point Parry writes:

". . . as a people Russians have for centuries been miserable and restless enough to want to escape their part of the globe in any direction whatever. They are the earth's only folk who years back coined the bitter saying—'From a good life you won't fly up'!"

The heart of Parry's book is its chapters on the Russians' current missile and space programs. He describes the Soviet missile arsenal in great detail. He gives similar treatment to the huge Soviet space boosters, their satellites and spacecraft and their scientific accomplishments in space.

This information can be regarded as highly authoritative. Parry, who came to the United States from his native Russia in 1921, has always been a wide reader of Soviet scientific and other publications and a compiler of bits of information disclosed in them. By this method over the years he has been able solely from published Soviet sources to put together the full picture of Russian rocketry presented in his book. In effect, Parry has conducted one of the most impressive one-man intelligence operations in the world.

Parry's book contains a few factual errors about American missilery. However, these for the most part can be attributed to the long lead-time perils of publication that confront an author writing about a rapidly changing field. They in no way should call into question other material in the book. This would be only a comfortable excuse to hide from the facts of Soviet progress.

Parry, speaking as an educator as well as an expert on Soviet affairs, states the meaning of those facts in blunt terms:

". . . a good idea if not active enough can be crowded off the world's stage by a bad idea that is on the march. Very sadly, there can be a kind of Gresham's Law in the history of ideas and of ways of life, too."

—J.B.

AN ENGINEERING APPROACH TO GYROSCOPIC INSTRUMENTS, Elliott J. Siff, M.S., and Claude L. Emmerich, D.Sc. Robt. Speller & Sons, 120 pp., $7.50.

In the words of the authors, this book is intended to fill the gap between the most elementary ad hoc explanations of gyroscopic effects and the complicated purely mathematic derivations associated with gyroscopic motion.

The book begins with a basic description of gyro characteristics and, with a minimum of mathematics, shows the design engineer how to apply these characteristics to new gyro problems. It attemps to strip some of the mystery from gyro design with relatively simple explanations of gyroscopics, Coriolis accelerations, and Schuler tuning. Finally, it describes some of the newest exotic designs —air bearings, electrostratic and electromagnetic suspension, vibrating gyros, and particle (nuclear spin) gyros—as well as many current applications.

Dr. C. S. Draper, in his foreword to the book, says it is "an effective effort to bring together the available information on gyroscopic devices as essential elements in an important and rapidly developing region of technology."

HUMAN ENGINEERING TESTING AND MALFUNCTION DATA COLLECTION IN WEAPON SYSTEM TEST PROGRAMS, A. Shapero and others, Stanford Research Institute, and C. Bates, Jr., Aerospace Medical Lab, for WADC. Order PB 161 832 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 52 pp., $1.25.

An analysis of the practices followed in nine Air Force missile system operations has led to the development of a recommended program for testing the performance of a system's operations.

Recommended procedures for performance testing include these steps: identifying and selecting the system's critical human operations; specifying the pertinent parameters of these operations; predicting the values these parameters will assume; confirming the predicted values through test.

The recommended method for dat collection on human initiated malfunctior is based on two techniques: identificatio of the specific operation during which malfunction is discovered; and the sy tematic collection of data on human-i itiated malfunctions, even where no equi ment breakdown is involved.

PERFORMANCE CHARTS FOR MULT STAGE ROCKET BOOSTERS, John S. MacK and Richard J. Weber. Order NASA Tec nical Note D-582 from National Aeronauti and Space Administration, Washington 2 D.C. 90 pp., $2.25.

Charts are presented of the stage pr pellant fractions of multi-stage chemical fueled rocket-booster vehicles.

Various stage combinations of R liquid-oxygen and hydrogen-liquid oxyge propellants are assumed, but the resul may be modified for other specific-in pulse combinations with little error.

The data are applicable to both o bital and escape missions. Examples a given to illustrate how the charts may b used to determine optimum staging ar thrust-weight ratios.

SEMICONDUCTORS AND TRANSISTOR by Dr. Alexander Schure. John F. Rider, Ne York. 144 pp., $2.90 (soft cover).

Another volume in Rider's Electron Technology Series, this discusses and eval ates the theory and characteristics of sem conductors and transistors.

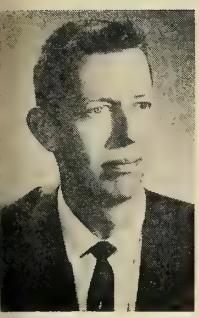
Coverage includes the basics of atom structure, quantum theory, conductors, i sulators, and semiconductors. Conductio by holes, semiconductors with impuritie and the semiconductor rectifier are an lyzed. The p-n junction under equili rium conditions and in reverse and fo ward bias, diode tubes (including phot diodes), and an extension of p-n junctio theory into the transistor are covere Considerable attention is given to bas design procedures in transistor amplifie Review questions are included at the e of each chapter.

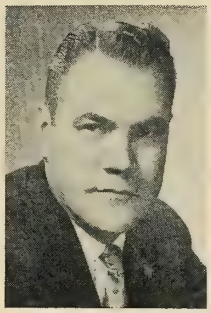
BASIC TRANSISTORS—Dr. Alexander Schu John F. Rider, New York. 152 pp., $3. (soft cover).

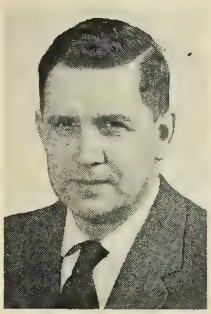
A comprehensive, but basic, covera of the transistor: what it is, what i made of, its unique characteristics, a how it differs from the vacuum tube.

The book opens with a discussion atoms and semiconductors and th analyzes the basic p-n junction dio Basic transistor circuits and their acti are described and analyzed.

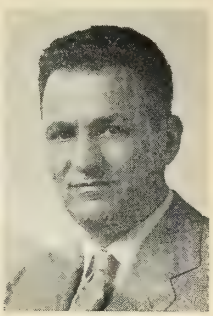
Coverage includes transistor biasi transistor characteristics, conventional a power transistors, amplifiers and os lators, and tetrode units. Review qu tions are included at the end of ea section.


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LOBB


FERRI

**Dr. Edward Teller** and **Dr. Joseph Kaplan:** Internationally known scientists and professors of physics at University of California, named senior technical advisors of Geophysics Corporation of America.

**Dan A. Kimball:** President of Aerojet-General Corporation, received Navy Distinguished Public Service Award for foresight leading to outstanding production capability of solid-propellant motors for *Polaris* fleet ballistic missiles.

**Al White:** Named chief test pilot of North American Aviation's Los Angeles Division. A veteran test pilot and engineer, he will continue as project pilot on the Air Force's 2000-mph B-70 bomber, which he has been assigned to fly for the first time in late 1962. **Scott Crossfield:** Former chief test pilot, transferred to space and information systems division to head a new engineering branch to test manned space systems. With North American since 1955, he was the first to fly the *X-15*. In new position, will supervise flight test program of Air Force *GAM-77 Hound Dog* missile, as well as help develop new manned spacecraft.

**Hervey J. Finison:** Appointed to new post of director-business planning and development for Raytheon Company's electronic components and devices group. **E. Kevin Kather** succeeds Finison as general manager of the semiconductor division. **Edward L. Dashefsky** promoted to general manager of the microwave and power tube division, and **Joseph F. Alibrandi** named manager of the Lowell, Mass. plant of the aero/weapons division.

**Stuart G. McGriff:** Appointed assistant director of research and manager of the Washington, D.C. office of Ionics, Incorporated. Prior to joining Ionics, he was product manager for fuels and propellants for Callery Chemical Company.

**James F. Healey:** Appointed general manager of Minneapolis-Honeywell's Aeronautical Division facility, St. Petersburg, Fla., succeeding **John W. Anderson,** who is taking leave for advanced university studies.

**Dr. R. Kenneth Lobb:** Former head of the aerodynamics department at the Naval Ordnance Laboratory, Silver Spring, Md., named program chief for aeroballistics. He replaces **Dr. Robert E. Wilson,** who was recently named associate director for aeroballistics.



## Recognition for Raborn

*Vice Admiral William F. Raborn, Director of Special Projects, Department of the Navy, received the National Aviation Club's Award for Achievement in recognition of his leadership in development of the Fleet Ballistic Missile Polaris, which became operational three years ahead of the target date.*

**John L. Roberts:** Named manager of the space technology division, Quantatron, Inc., Santa Monica, Calif. Will be responsible for the coordination of a scientific team studying the problems of space vehicle systems and developing "hardware" to support requirements of such systems.

**Dr. Adolph K. Thiel:** Director of space systems program management and acting director of the new fabrication, integration and test division; **Dr. Robert R. Bennett,** program director for the *Minuteman* weapon system; and **Dr. W. S. Carlson,** director of electromagnetic systems division; all named vice presidents at Space Technology Laboratories, Canoga Park, Calif.

**Dr. Manfred Mannheimer:** Noted for his work in the physical sciences, joins the Systems Research Center of Lockheed Electronics Co., Bedminster, N.J., to engage in projects involving propagation, nuclear fusion and re-entry.

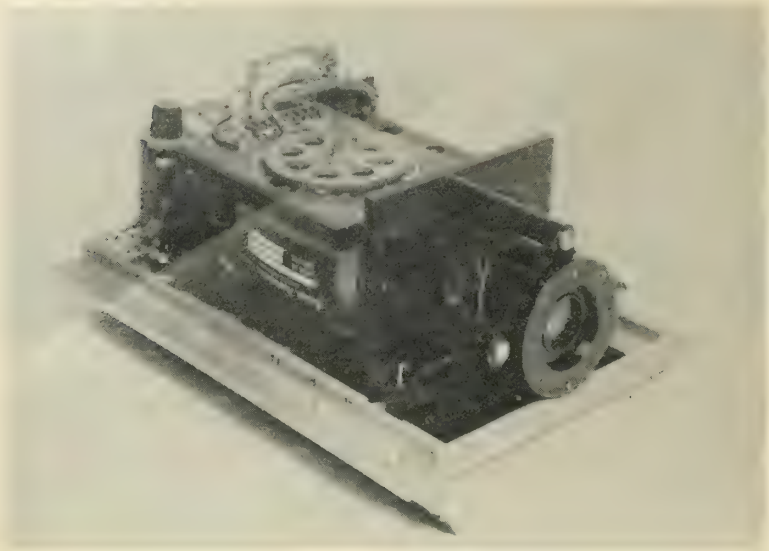
**Jack T. Wills:** Named to Aerojet-General Corporation's Washington staff as director of corporate special projects. **L. Wayne Mullane,** manager of Aerojet-General's Downey, Calif., plant since its acquisition from Rheem Manufacturing Co. in June, 1959, elected vice president.

**Frank W. Lehan:** Elected executive vice president of Space Electronics Corporation. Former director of the electronics laboratory at Space Technology Laboratories, Inc., he has been vice president of SEC since 1958.

**B. E. Stitt:** Appointed chief project engineer-*Nike* systems for the Douglas Aircraft Company, Santa Monica, Calif. With Douglas since 1951, he participated in the first *Nike-Ajax* and *Nike-Hercules* firings. **G. F. Hanson** will replace Stitt as head of the company's space activities at Cape Canaveral. **W. L. Duval,** appointed assistant chief engineer for missiles and space field operations, was Douglas' first field station manager at both White Sands and Cape Canaveral.

**Dr. Antonio Ferri:** Elected president of General Applied Science Laboratories, Inc., Westbury, N.Y., succeeding **Edward Weitzen,** who resigned to become executive vice president of Electronic Teaching Laboratories of Washington, D.C. Weitzen remains a director of GASL. Dr. Ferri was one of the founders of the company.

**R. E. Bischoff:** Manager-Detection and Surveillance Products Sales for General Electric's Light Military Electronic Department, has been named general chairman of the Seventh National Communications Symposium, sponsored by the Institute of Radio Engineers Professional Group on Communications Systems.



## Infrared Grating Spectrometer

A small, rugged, lightweight infrared grating spectrometer is available from Block Associates, Inc. The Grating Spectrometer will scan the spectral range of 1.5 to 4.5 microns in 3.0 seconds with a resolution better than 0.1 micron.

Other spectral regions may be selected to suit the application. The electrical output of the instrument is commutated so that information related to the analysis of the spectral radiation—internal calibration, chopper temperature, amplifier zero, detector temperature, etc.—may be observed between spectral scans. This feature is especially useful for telemetry from remote field installations.

The performance of the Grating Spectrometer is virtually unaffected by severe vibration or accelerations to 15 g's.

Circle No. 225 on Subscriber Service Card.

## Telemetering Accelerometer

A miniature telemetering accelerometer is available from Giannini Controls Corp. The Model 24155 weighs less than 2.5 ounces, occupies 1 cubic inch, and operates with linearity and repeatability of ±1% and hysteresis of 1%. Available in resistance ranges from 2000 to 5000 ohms yielding a 0.5% resolution, the accelerometer is supplied in ranges from ±2 g to ±25 g at natural frequencies from approximately 20 to 70 cps. Range can be extended to +100 g with natural frequency of 145 cps, and switch output can be provided in place of potentiometric output.

Circle No. 226 on Subscriber Service Card.

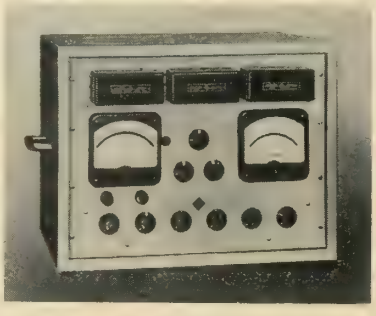
## High MEGOHM Bridges

Mid-Eastern Electronics, Inc., is marketing the Model 801 and Model 802 Bridges, both designed for accurate measurement in the ultra high resistance ranges.

The Model 801 Bridge is a self-contained unit complete with built-in battery power supply (0=250 volts DC), electrometer amplifier galvanometer and nine plug-in ratio arms. No auxiliary equipment is necessary and the bridge can be made ready for operation in only ten seconds.

The Model 802 Bridge is identical to the Model 801 throughout, except that a 100 meg decade (ten steps-10 megohms/step) is included, and the 100 ohm decade of the 801 is omitted.

Circle No. 227 on Subscriber Service Card.



## Low Temp Fluxless Solder

A low temperature fluxless solde TIN-A-LUM, which eliminates t danger of metal destruction under he is available from Metals For Indust Inc.

TIN-A-LUM joins any dissimil metal together and can be used on kinds of materials with the aid of soldering iron or a light flame and wit out any flux whatsoever. This sold has proven to be of such tensile streng that it can even replace welding brazing in many instances and at ve much lower cost and less time.

Circle No. 228 on Subscriber Service Card.

## Sub-Carrier Oscillator

PACE Engineering Co. is marketi their Model CT10 Telemetering Su carrier Oscillator System, providing compact and reliable telemetering u for operation with up to 12 variab inductance transducers.

The instrument's module case a cepts six printed circuit Sub-Carri Oscillator cards, which together wi appropriate transducers may be tun to any of the IRIG bands, 4 throu 18 or optional bands, A through Included, also, is a Dual Chann Composite Amplifier that receives t summed output frequencies from t Inductance Oscillators and feeds t transmitter.

PACE Model CT10 Telemeteri Sub-Carrier Oscillator Systems a available for operation on any specifi voltage, and have frequency stability ±1% of the bandwidth for ±5 change in operating voltage.

Circle No. 229 on Subscriber Service Card.

## Micro-miniature Capacitor

A line of micro-miniature tantalu capacitors is available from Compo ents, Inc. The capacitors are the sm lest non-polar solid tantalum capacitc made that are stable over a wide ran of frequencies and temperatures. T units are available in production quan ties in a range of values from 0.001 0.0047 MFD which operate at 50 VI and from 0.0068 to 0.047 MFD lower voltages. They operate at fu rated voltage from −55°C to +85°C

Circle No. 230 on Subscriber Service Card.

## Tape Recorder Analyzer

Telemetrics, Inc. has packaged in a single unit a solid state analyzer f rapid and complete checkout of a digital tape recorder.

The self-contained unit is capab

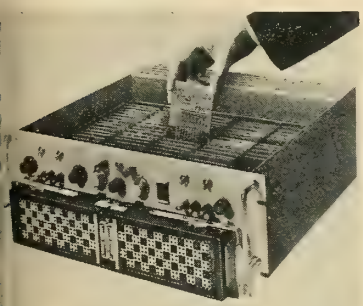
of performing all fundamental measurements to determine operational status of a recorder. The unit employs techniques to measure start and stop distances, dynamic skew, and dynamic speed variation appearing as wow and flutter.

Accuracies for distance measurements are 0.01 inches resolution to .003 inches; skew measurement: 2% at 1 volt peak per microsecond. Speed variations are 1% on 100 microsecond range, 0.2% on ranges of 3, 30, and 200 milliseconds, and 1 second.

Circle No. 231 on Subscriber Service Card.

## PAM & PDM Simulators

Telemetrics, Inc. has available a 300 Series of solid state Electronic Signal Simulators providing a selection of PAM, PAM-NRZ, and PDM units with extreme flexibility to match ever-changing operational requirements in their many applications.



The 300 Series includes units with 3-channels of subcommutation. Other channels can be added through patching, by counts of one, two channels per frame up to 1054 per frame. Complete flexibility in patching combinations provides for location of any number of missing reference pulses and dynamic pulses in the frame.

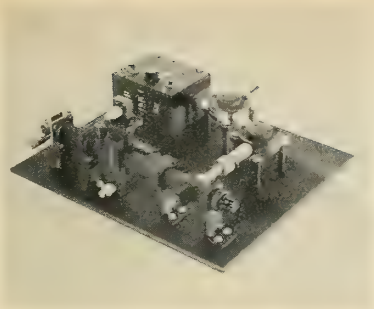
Circle No. 232 on Subscriber Service Card.

## Rubidium Frequency Standard

The Rubidium Frequency Standard, a readily portable, independent atomic frequency standard, will be available from Space Technology Laboratories, Inc. in April. It weighs 20 lbs., displaces 1.6 ft$^3$ and is unaffected by terrestrial or space environmental conditions expected to be encountered in its normal operation.

Atomic resonance, recognized as the most stable frequency base, is the fundamental principle of the device. The basic frequency reference is an optically pumped rubidium cell. Output frequencies are 5 and 1 megacycles; and 100 kilocycles.

Circle No. 233 on Subscriber Service Card.



## Four Band Paramps

Low noise, stable, environmentally qualified parametric amplifiers for L, S, C and X-bands are available from Hughes Aircraft Co. components division.

One model is an S-band non-degenerate model with a noise figure of less than 3 db including circulator loss from −10° to 70°C.

The firm has measured noise figures as low as 1.9 db at S-band in their laboratory with bandwidths in excess of 80 mc at 15 db gain. Each parametric amplifier includes a basic amplifier body, a varactor diode, a circulator, pump power monitor, and a klystron.

Circle No. 234 on Subscriber Service Card.

## Thermoelectric Kit

General Thermoelectric Corp. has available a Type 300 Thermoelectric Experimental Kit designed for electronic, industrial, medical and educational organizations. This kit makes it possible to obtain empirical knowledge directly of thermoelectric materials, principles and techniques in a planned and organized manner.

Circle No. 235 on Subscriber Service Card.

## Solid State Power Supply

Philbrick Researches, Inc., has available an all solid state Dual Power Supply for energizing transistorized electronic equipment. Designed to take full advantage of semiconductor components, the Model 6033 Power Supply operates from 115 vac and provides 2 fixed voltage outputs: ±15 volts dc, each at 200 ma.

The Supply is not damaged even by a prolonged short circuit, because short circuit current is always less than full load. When one-half of the supply is shorted, the voltage of the other half falls well below 15v, and no fuses or breakers are needed.



Circle No. 236 on Subscriber Service Card.

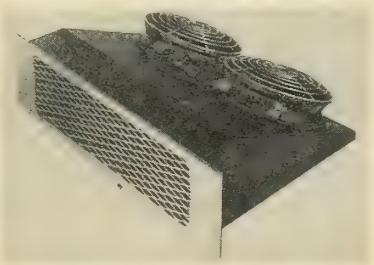
## Improved Tantalum Powder

A tantalum powder to improve the fabrication and performance of electrolytic capacitors is now available from the Metals Division of National Research Corp. The SGP powder enables pellets to be pressed to lower green densities, lowering dissipation and increasing capacitance per gram. At the same time, the product retains the outstanding electrical properties and high chemical purity of the company's SGN powder.

Circle No. 237 on Subscriber Service Card.

## Cabinet Flushing Fans

Twinpax, a new concept in cabinet flushing fans, are available from Rotron Manufacturing Co., Inc. The two fans working in parallel produce a delivery of 450 cfm free delivery, or 400 cfm at 0.1 in. wg static pressure,—when operating on either 208 vac 60cps 3 Ø or 115 vac 60cps 1 Ø power. The fans are placed at an angle in the assembly, thereby directing the air flow at the most advantageous path minimizing "dead spots" and eddying within the cabinet.



Circle No. 238 on Subscriber Service Card.

## Radar Beacon Checkout

Astronautics, Inc. is marketing a radar beacon checkout unit. Model RBCC-1 is designed for multiple functions in relation to a C-Band beacon. Included are the following parameters: threshold, power output, countdown and beacon delay and repeater if required. Comparable units are available for each of the various bands.

The RBCC-1 is designed for mean operation at 5600 MC, although the unit is available in ranges from 1 KMC to 12 KMC operation. Test time with the RBCC-1 including set-up and calibration does not exceed 45 seconds.

Circle No. 239 on Subscriber Service Card.

# contracts

## NASA

$250,000—Lear, Inc., for studies on Project *Apollo*. Subcontract from General Electric's Missile and Space Vehicle Dept., Grand Rapids, Mich.

## MISCELLANEOUS

**The Garrett Corporation's AiResearch Manufacturing Co.** Los Angeles, awarded 3-year contract by **North American Aviation's Space and Information System Division** for study of requirements, design concepts, and integration of environmental control systems for future space vehicles. No amount disclosed.

**Douglas Aircraft Company,** Santa Monica, Calif., with **National Engineering Science Co.,** Pasadena, Calif., for research program in advanced areas of missile and space sciences. Specialized research projects which Douglas will assign to NESCO will involve such fields as high-temperature materials, solid-state physics, aerothermochemistry, thin-shell dynamics, fluid dynamics and reaction controls. No amount disclosed.

**Lockheed Aircraft Corporation,** to work out an automatic timetable system for charting flight paths in space for low-thrust rockets. Amount not disclosed.

## NAVY

**Developmental Engineering Corporation,** Leesburg, Va., has been awarded a Communications Moon Relay System follow-on contract to provide CMR with a single-side band operation with the current CMR frequency-shift keyed system. Amount not disclosed.

$650,000—**Summers Gyroscope Co.,** Santa Monica, Calif., for free gyros to be used in advanced *Terrier* and *Tartar* guided missiles. Subcontract from **Convair/-Pomona, Convair Div. of General Dynamics Corporation.**

$113,590—**Yale University,** New Haven, Conn., for preparation of a catalog of positions of the stars in the Southern Hemisphere.

$44,999—**Convair Division, General Dynamics Corp.,** Pomona, Calif., for technical nonpersonal services of experimental factory personnel, facilities and equipment to design and prepare drawings covering final inspection gages for *Polaris* and *Tartar* missiles.

## ARMY

$2,833,884—**Raytheon Manufacturing Co.,** Waltham, Mass., for continuation of work on the *Hawk* missile.

$2,440,879—**Sperry Rand Corp.,** Salt Lake City, for engineering services, ground handling and test equipment for *Sergeant* guided missile system; two contracts.

$1,740,000—**Pan American World Airways, Inc.,** New York City, services and material for planning, development design, installation, operation, maintenance, and modernization of Electronic Environmental Test Facility at Electronic Proving Ground, Ft. Huachuca, Ariz.

$1,700,000—**Beech Aircraft Corp.,** Wichita, Kan., for production of an additional quantity of Beechcraft *Model 1025* missile targets.

$313,953—**Lear, Inc.,** Santa Monica, Calif., for research and development of gyroscopes.

$200,000—**Summers Gyroscope Co.,** Santa Monica, two contracts from **Beech Aircraft Corp.,** Wichita, Kan., for position-and-rate gyros and system components for use in surveillance missiles.

$149,259—**Nortronics, Division of Northrop Corp.,** Anaheim, Calif., for *Hawk* missile system spare parts.

$128,986—**Stanford Research Institute,** Menlo Park, Calif., for research and development work leading to establishment of design for microwave filters and coupling structures.

$99,566—**Federal Systems, Division of International Business Machines, Inc.,** Kingston, N.Y., for research work in the field of "thin-film circuit functions" and periodical technical reports relative thereto.

$79,668—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for research and development in design and development of remote setting microbaroswitch.

$75,000—**Stanford University,** Stanford, Calif., for continuation of R&D work to investigate "Solid-State Two-Level High-Power Maser."

$64,379—**RCA Laboratories,** Princeton, N.J., for research and development in the study of low-noise electron beams.

$33,783—**Advanced Technology Corporation,** Goleta, Calif., for study of gun-boosted rocket systems.

$31,402—**Gilfillan Brothers, Inc.,** Los Angeles, for *Corporal* missile system repair parts.

**The Keystone Electronics Co.,** Newark, N.J., awarded several contracts by **Raytheon Manufacturing Co.** for development of filters on the *Mauler* program. Amount not disclosed.

## AIR FORCE

**Hamilton-Standard Division of United Aircraft Corp.,** Windsor Locks, Conn., two contracts from **The Martin Company** for ground support equipment for use in the development of the *Titan* II ICBM. No amount disclosed.

$3,000,000—**North American Aviation's Los Angeles Division,** to modify F-100 Super Sabres to carry and launch *Bullpup* air-to-surface missiles.

$1,500,000—**North American Aviation's Space and Information Systems Division,** Downey, Calif., for study of ways to provide environments required by man and his equipment in space. Program is entitled "The Space Vehicle Thermal and Atmospheric Control Study" and is expected to last 3 years.

$1,250,000—**Aerojet-General Corporation,** Azusa, Calif., for construction of a facility to test and manufacture infrared subsystems for the *Midas* satellite.

$566,126—**Convair Div., General Dynamics Corp.,** Pomona, Calif., for a high-temperature, nuclear radiation-resistant pneumatic system for operating the flight control surfaces of supersonic aircraft or missiles.

$361,459—**AVCO Corporation (Everett Research Laboratory),** Everett, Mass., for research on "Plasma Propulsion."

$278,148—**Texas Instruments, Inc.,** Dallas, for PCM telemetry recording system.

$257,543—**G. W. Galloway Co.,** Baldwin Park, Calif., for construction of a liquid-solid propellant test facility at Test Site #1, Edwards AFB, Calif.

$196,374—**General Precision, Inc., Kearfott Div.,** for gas-bearing gyros for space missions.

$100,000—**University of Illinois,** Urbana, for research into the basic properties of gaseous plasmas.

$60,800—**Radio Corporation of America,** Camden, N.J., for investigation of transportable search radar and IFF beacon.

$54,804—**Lockheed Aircraft Corporation (Missile Systems Division),** Sunnyvale, Calif., for continuation of research on the theory of composite propellant burning.

$50,000—**University of California,** Berkeley, for continuation of research on "High Precision Geocentric and Interplanetary Orbits."

$50,000—**RIAS Division,** Baltimore, for research on "Properties of Conduction Electrons in Ionic Crystals.

$41,912—**Thiokol Chemical Corporation, Reaction Motors Division,** Denville, N.J., for rocket exhaust sampling system for two-phase flow systems.

$40,000—**Raytheon Company, Research Division,** Waltham, Mass., for investigation of effects of ion-induced defects on surface reactions.

$38,537—**Texaco Experiment, Inc.,** Richmond, Va., for continuation of research on "Properties of Ion in Flames."

# letters

## Carriers and Space

*To the Editor:*

Permit me to be the first to accep your invitation (Editorial, M/R, Feb. 20 p. 50) by suggesting that manned space ships can and *should* be launched an recovered at sea from modern "carriers."

Please feel free "to burn this letter" as you will not be the first—suggestion for launching propeller aircraft, jet air craft, missiles and rockets at sea were also originally burned.

John D. Nicolaides
Technical Director for
Astronautics
Bureau of Naval Weapons
Department of the Navy
Washington, D.C.

*First letter was burned; this is the second.—Ed.*

## Meteorites No Hazard

*To the Editor:*

The general use of the term, "meteo rite," for particles orbiting in outer spac prompts me to point out that according t Noah Webster there are no meteorites i outer space!

Our technical reports and magazine as well as newspapers persist almost unan imously in referring to the particles a meteorites and micrometeorites. Man Space-Age writers are apparently follow ing the wrong path taken by pioneers i this relatively new field when a look i the dictionary could quickly set them straight.

The definition of a meteorite is, "a stony or metallic body which has falle to earth from outer space," and a meteo roid is defined as, "one of the countles small solid bodies in the solar system which become meteors on entering th earth's atmosphere." Therefore, we hav meteoroids in outer space, which burn a visible meteors when they enter th earth's atmosphere and finally becom meteorites only if they survive their fier journey and fall to the earth's surface Thus, the meteorite is the cinder of a par tially burned meteoroid to be found o the earth.

In our museums we can see meteo ites, which have been picked up from th ground, and someday we may be abl to see meteoroids which have been picke up from space. However, since it is highl unlikely that any meteorites will ever b encountered in outer space, let's equi our satellites with micrometeoroid de tectors and our space ships with protectio against meteoroid impact and leave th meteorites in the museum where they be long.

Richard B. Hoag
Member of the Technical Staff
Space Technology Laboratories,
Inc.
Los Angeles

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# —when and where—

## MARCH

**Eleventh Annual Instrument Society of America Conference,** Roosevelt Hotel, Pittsburgh, Mar. 8-10.

**Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, sponsored by IRE, AIEE, IAS,** University Museum, Philadelphia, Mar. 9-10.

**Institute of the Aeronautical Sciences, Flight Propulsion Meeting, (classified)** Cleveland, Mar. 9-10.

**American Society of Mechanical Engineers, Aviation Conference,** Statler-Hilton Hotel, Los Angeles, Mar. 12-16.

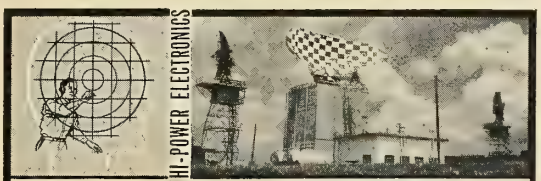
**American Rocket Society, Test Operations and Support Conference,** Biltmore Hotel, Los Angeles, Mar. 13-16.

**1961 Missile/Space Conference and Goddard Memorial Dinner of the National Rocket Club,** Sheraton Park Hotel, Washington, D.C., Mar. 14-16.

**Inter-Station Supersonic Track Conference, (confidential), Sixth Supersonic Track Symposium,** U.S. Naval Ordnance Test Station, China Lake, Calif., Mar. 14-16.

**Fifth National Conference on Aviation/-Space Education,** Mayflower Hotel, Washington, D.C., Mar. 16-18.

**American Astronautical Society Symposium, Interactions of Space Vehicles with an Ionized Atmosphere, cosponsored with AFOSR and ARPA,** Sheraton Park Hotel, Washington, D.C., Mar. 17.


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Agency—Cunningham & Walsh, Inc.

Atomics International, a Div. of North American Aviation, Inc. . . . . 11
Agency—Batten, Barton, Durstine & Osborn, Inc.

Autonetics, a Div. of North American Aviation, Inc. . . . 51
Agency—Batten, Barton, Durstine & Osborn, Inc.

Cannon Electric Co. . . . . 8
Agency—Anderson-McConnell Adv. Agency, Inc.

FRX, Inc. . . . . 49
Agency—Beecher Assoc.

Government Products Group-American Machine & Foundry Co. . . . . 35
Agency—Cunningham & Walsh, Inc.

Grand Central Rocket Co. . . 52
Agency—Foote, Cone & Belding

Lockheed Aircraft Corp., Missiles & Space Div. . . . . 6, 7
Agency—Hal Stebbins, Inc.

Martin Co., The, Denver Div. 30
Agency—E. M. Halvorson Co.

McDonnell Aircraft Corp. . . . 19

Monsanto Chemical Co., Corporate Div. . . . . 2, 3, 4
Agency—Gardner Adv. Co.

Northrop Corp., Radioplane Div. . . . . 22
Agency—Doyle, Dane, Bernbach, Inc.

Sperry Utah, a Div. of Sperry Rand Corp. . . . . 20
Agency—Reach, McClinton & Co., Inc.

Stratoflex, Inc. . . . . 10
Agency—Magnussen Adv. Agency

Thiokol Chemical Corp., Rocket Operations Center . 39
Agency—Hicks & Greist, Inc.

Vitro Electronics, a Div. of Vitro Corp. of America . . 37
Agency—Sam J. Gallay Adv.



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editorial . . .

# Let's Not Hang an Untried Man

ONE OF THE toughest jobs in the Kennedy Administration is that held by the new chief of the National Aeronautics and Space Administration, James E. Webb.

Not only does he head an agency whose success or failure will reflect globally on the prestige of the President and of the nation, but he has inherited a number of vexing internal problems.

No one is more aware of this than Mr. Webb.

A weekly aviation publication has termed Mr. Webb's appointment a great disappointment. We do not agree. Nor do we know yet if we will disagree.

What we do say is this: James E. Webb deserves a fair chance to tackle the important job he has accepted without being labeled a failure before he starts.

President Kennedy was well aware at the time he selected Mr. Webb that his new NASA chief was not a scientist. Mr. Webb was one of those who made this point to the President most emphatically. But what the President wanted was a good administrator, a man with the ability to run a sizeable organization and to help create an effective national space policy.

He has his administrator. Whether he has a good one remains to be seen.

But we are inclined to go along with President Kennedy's belief that it does not necessarily take a scientist to run a scientific organization. Other abilities, not frequently found in a first-rate scientist, may be more important.

Mr. Webb has had more than a dilettante's interest in science. While Under Secretary of State, he introduced the practice of assigning science attaches to major embassies, a long overdue recognition of the importance of science in the conduct of our national affairs. He also has been very active in a program to improve high school physics courses, certainly a foundation-stone of our national scientific well-being.

Mr. Webb is aware that there is a strong feeling against his appointment inside some scientific quarters of NASA itself. He is hopeful of overcoming this.

He told a visitor to his office last week he does not feel his job is to tell NASA's scientific staff in detail what to do, but to create an atmosphere of creativity in which scientific work and innovation can flourish. If he succeeds in doing that, he will have gone far toward healing any breach. His awareness of the problem is a big step in the right direction.

Mr. Webb also is aware of the potential dangers of the conflict between NASA and the Air Force for scarce space dollars. To say that this has at times verged on bitterness would be understating it.

Mr. Webb has met the problem head-on by discussing it with the senior military officers involved.

"I am sure we will have the closest cooperation among the senior officers of all the departments concerned with space activities in the interest of an effective national program," he says. He has both given and received assurances of that.

THIS DOES NOT mean the NASA chief expects all competitive feeling between NASA and the Air Force to disappear at more junior levels. He regards this as natural, and not necessarily undesirable.

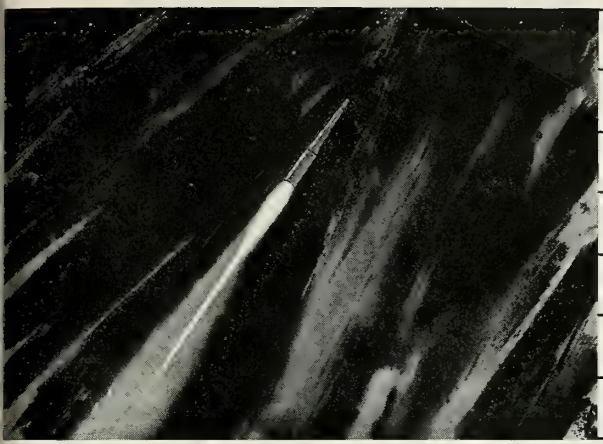
Nor did Mr. Webb accept his post to preside over the dismantling of NASA in favor of a rapidly expanding Air Force space capability. There is a need and room for both.

The new administrator is engaged with his staff in a thorough review of the agency's Ten-Year Program for space, similar to the military reviews delivered to the President by Defense Secretary McNamara. In this period, Mr. Webb has kept his door open to industry. Several company presidents who have telephoned for an appointment have been told: "Come on over right now." We will watch with interest the program which emerges.

We will be among the first to criticize Mr. Webb if we feel he has made a mistake. Meanwhile, we will withhold judgment.

Let's not hang a man before he commits a crime.

**William J. Coughlin**



# A SECOND SHOT HEARD ROUND THE WORLD:

On February 1st, a new American missile roared upward from its pad at Cape Canaveral. It was the Air Force Minuteman. It was the first flight of a three-stage intercontinental ballistic missile. It was a success.

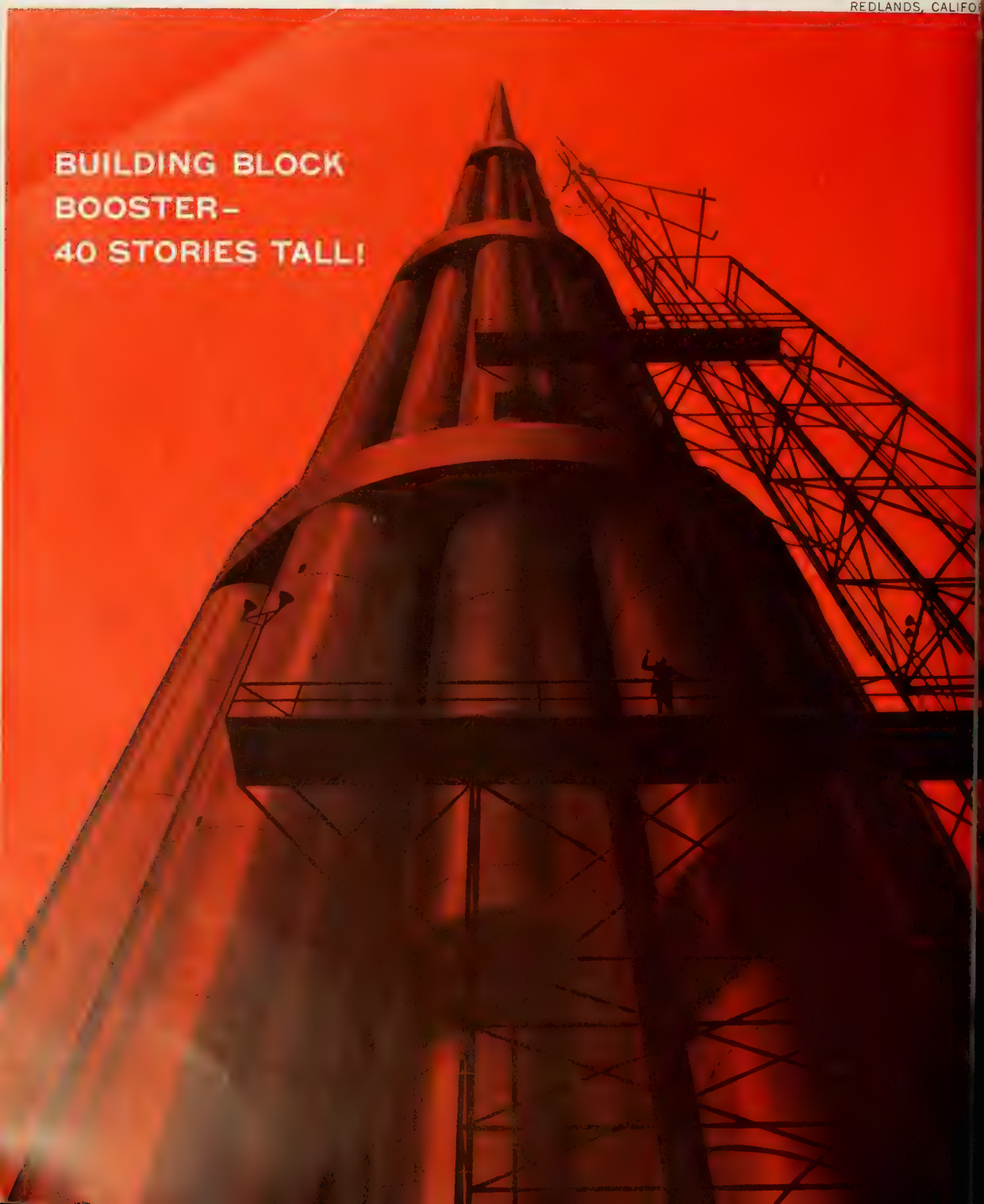
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pounds — can be available by 1964. **GRAND CENTRAL ROCKET COMPA**

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MARCH 20, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

MAR 1961




## Cost Bind Hurts Plan To Bolster Small War Forces

- NASA Funds Solid Boosters
- Promising New IR Transducer
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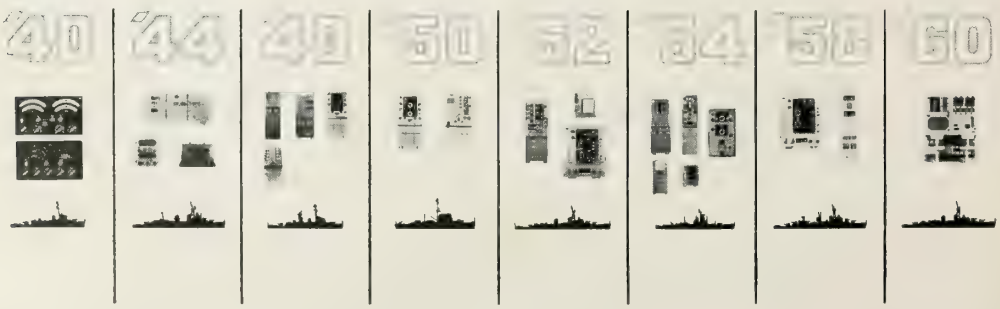
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Volume 8, Number 12 March 20, 1961

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## THE COVER

*Little Joe 6 stands ready for launching at Wallops Island, Va. Firing scheduled for last week was final qualification of capsule before manned flight. See p. 15.*

## MARCH 20 HEADLINES

Price Bind Crimps Plan to Add Small War Forces .... 12
Conference Told Zeus Can be Anti-Satellite Weapon 14
Added Redstone Shot May Delay Manned Flight .... 15
NASA Starts Funding of Big Solid Boosters ..... 16
Siddeley SEREB Urge Joint British-French Effort ..... 18
Nuclear Space Transport Feasible within Decade .... 24
Three Firms to Study Vehicles beyond Saturn Class .. 28

## SUPPORT EQUIPMENT

Seals Protect ICBM Crews Against Nuclear Attack .... 23

## ELECTRONICS

Advanced IR Transducer Offers New Advantages ..... 25

## SPACE SYSTEMS

How Ranger's Lunar Payload Will be Sterilized ..... 27

## ADVANCED MATERIALS†

Press Forging Multiplies Strength of Castings ..... 30
High-Temp, High-Vacuum Furnace Expands Easily .. 31

## SPACE POWER

Designer Says Systems Must be Flight-Tested Soon .. 32

## INTERNATIONAL

How U.S. Government Aids Missile Salesmen Abroad 38

## DEPARTMENTS

Publisher's Memo .... 7
The Countdown ..... 9
The Missile/Space Week† ..... 10
Technical Countdown . 21
Soviet Affairs ..... 40
Contracts ..... 42
Products & Processes . 44
Names in the News .. 47
Letters ..... 48
When and Where .... 49
Editorial ..... 50

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*BUSINESSPAPER EDITORS Joseph Scheleen (Traffic World), Edward Lally (American Metal Market), William E. Howard (Missiles and Rockets), and Redington Fiske (Export Trade) address the New York Sales Executives Club.*

# memo from the publisher

THE FOUR MEN pictured above are editors from leading businesspapers in broad fields of American industry. They are half of a panel put together last month by Associated Business Publications, of which MISSILES AND ROCKETS is a member. The panel met at a luncheon of the influential New York Sales Executives Club to discuss important business changes expected during the next ten years.

MISSILES AND ROCKETS was asked by ABP to represent the missile/space market. We asked Managing Editor Bill Howard to boil down to a three-minute presentation everything that's liable to happen in the next ten years. Quite a task!

But separating the wheat from the chaff is nothing new to Bill Howard. As M/R's managing editor, in addition to directing the magazine's news and technical coverage, he's got to wade through mountains of staff-written and contributed copy, press releases and trade literature announcements to decide what items are important enough to be included in the current issue.

Bill Howard is well-qualified to sit behind the Managing Editor's desk, and you might want to learn more about the man who decidedly plays such a major role in what you're going to be reading every week.

Born in Albany, N.Y., Bill attended Dartmouth and Union Colleges and cut his journalistic teeth on European assignments for the *Stars and Stripes* during World War II. Since then he has undergone a honing process, first with a half dozen newspapers around the country and then for eight years with United Press International, that has turned him into one of the sharpest newsmen in the business.

You name it and he has probably written about it; from congressional hearings to hurricanes, from brinksmanship to capturing Brinks bandits, from white slavery to the White House. As a Washington newsman of long standing, he is an authority on matters political and the machinery of Federal government. By a rather strange twist of fate he covered the explosion and fire aboard the aircraft carrier Bennington in 1954, meeting the skipper, Admiral William F. Raborn—about whom he would later write a book under far different circumstances.

During his last few years at UPI, Bill discovered a new interest for his writing talents, the fast-moving developments in the science and technology of the missile/space field. We were fortunate in luring him away in February 1959 to become M/R's Ground Support Equipment editor; his broad understanding of the industry and outstanding reporting-in-depth prompted us to move him up to the Managing Editor's slot in May of 1960.

An author as well as an editor, Bill and M/R Military Affairs Editor Jim Baar have co-authored the successful book "Polaris!" for Harcourt Brace, and are currently working on another missile book to be published in the fall of 1961. Last week's issue of "This Week" magazine carried their by-line story on the first *Polaris* submarine peace patrol.

Howard lives in Chevy Chase, Md., with his wife, Helen, and three young sons, and steals enough time away from his editing and writing career to pursue his hobby of oil painting. He's one of the biggest reasons why we are able to say "If it's important in missiles and space, you'll read about it first in M/R."

Edward Mudefeld

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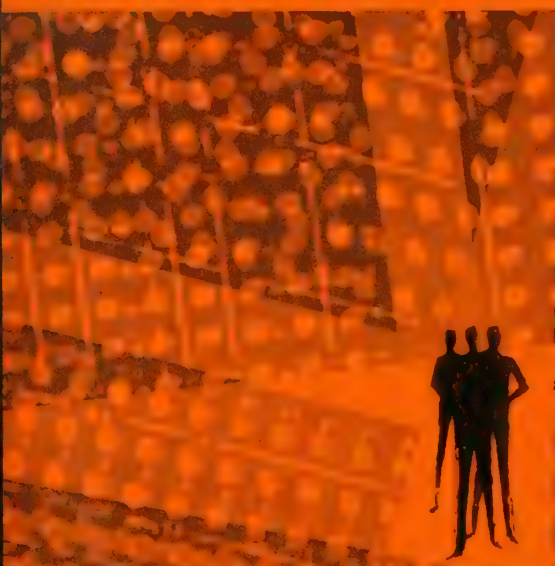
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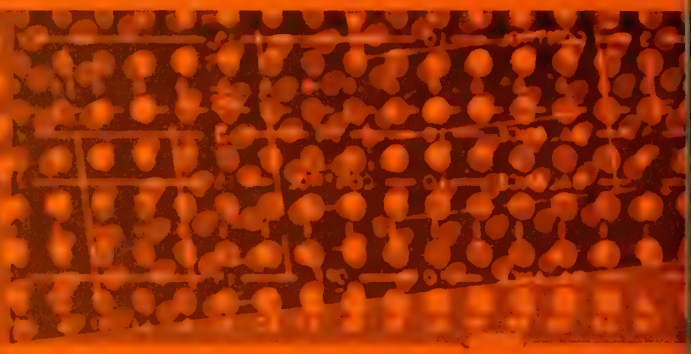
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# The Countdown

## WASHINGTON

### Where's the Space Frontier?

Muttering grows louder on Capitol Hill over the continuing hold-up of the Kennedy Administration's promise to get the space program moving forward again. One of the big disappointments is the delay of the National Space Council, headed by Vice President Johnson, in getting organized. So-called "legal technicalities" restraining activities of the Council, COUNTDOWN is told, "could be corrected in about two minutes flat by Congress." Several influential men around Congress also are making it known that they are "quite disappointed" in the apparent lack of direction shown thus far by NASA Administrator James E. Webb.

### Communications Polar-Orbiter Shelved

The Army has dropped at least for the present work on development of *Steer*, a polar-orbitting communications satellite that was incorporated in the *Advent* program. *Steer* would have provided a satellite communications net in the polar regions that cannot be reached by the 24-hour GE-Bendix *Advent* system. However, *Steer* may be reinstated later.

### Dyna-Soar on the Brink

The ARDC push to greatly increase funding of the *Dyna-Soar* program is based on the argument that the present funding plan is a time-waster. As one informed official put it: "The program has reached the point where if we are going to do anything with it now is the time."

### Minuteman: Two for One

COUNTDOWN hears firmer and firmer reports that a second source for *Minuteman* is in the works in the Pentagon decision-mill. The two main reasons given are plans to increase the deployment rate and the Administration's search for anti-recession measures.

### Nike-Zeus vs. Enemy Satellites

The Western Electric *Nike-Zeus* as presently designed has long been considered capable of downing satellites, as well as missiles, with little modification. But the satellites would have to be within about a 200-mile orbit. Now, the Army discloses that with major modification *Zeus* could bat down satellites in 1200-mile orbits. However, the major modifications probably could not be completed before about 1967.

### Rocket-boosted Artillery

Army and Navy missilemen are taking an increasing interest in the development of rocket-boosted artillery shells with HE warheads. A number of engineers see in them at least one good possible answer to the growing need for a cheap HE-tipped missile. (See page 12.)

### B-70, ANP and the Knife

In searching for dollars in the defense budget, the Administration is reported looking ever more hungrily at the B-70 and ANP programs. The present (but still fluid) outlook: A deep slash in B-70 and continuation of ANP on a strictly R&D basis and along only one road.

## INDUSTRY

### JFK Blessing Small Business

The Kennedy Administration's search for means to spur on the U.S. economy and cut unemployment is increasing pressure on DOD to channel contracts to Small Business. The White House pressure also is directed toward passing the manna to depressed areas. This is not a matter of hopes and good wishes. This is what the marching orders are saying.

### Missileer Hopes Brighten

Some top Navy brass is hopeful of getting a go-ahead for the Missileer plane to carry the *Eagle* air-to-air missile. Latest feeling is that if funds are forthcoming they will be earmarked for Missileer, not for modifying an existing aircraft.

### Trainers for Astronauts

Air Force is looking over a North American Aviation proposal for two additional *X-15* rocket planes for use as two-place trainers for astronauts. Initial reaction to the idea is said to be favorable.

### R&D Intelligence

Thiokol Chemical Corp. is in pilot production of a new solid propellant with hydrocarbon polymers base that is said to have excellent elongation and low temperature characteristics . . . Component testing of NASA's Orbiting Astronomical Observatory will be done with *Aerobee 150-A* rockets equipped with an Aerojet-General 44.4-lb. attitude control system.

### Centaur Flight Slips

First launching of *Centaur* liquid oxygen-hydrogen rocket is slipping to "late 1961." NASA wants additional engine development to clear up conditions which led to two explosions recently on Pratt & Whitney test stands.

## INTERNATIONAL

### Spadeadam Still Lives

While the European Space Club debates the use of *Blue Streak* as a booster, Britain is keeping its Spadeadam Test Facility open at a cost of $850,000 per month. Total expenditure on the *Blue Streak*, developed at Spadeadam, is put at $240 million to date.

### Overseas Pipeline

A delegation from France will visit the U.S. soon to talk over development of satellite instrumentation to be launched by a NASA *Scout*. A similar group from Japan headed by Dr. Kankuro Kaneshige of the National Space Activities Council has just completed a tour of NASA facilities to see about its *Scout* project . . . Britain will spend $430 million to arm its V-bombers with *Skybolts* . . . *Skylark* high-altitude sounding rocket firings are under way at Woomera. Shot March 6 released a sodium vapor cloud at 100-120 miles.



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# The Missile/Space Week

## Dr. Brown for Dr. York

The man who will succeed Dr. Herbert York in the key post of Pentagon R&E Director is a physicist, an authority in nuclear reactor design and one of the youngest men to join the Kennedy Administration.

The 33-year-old new R&E chief, Dr. Harold Brown, is the director of Lawrence Radiation Laboratories. He is also a consultant of Aerojet-General, the Air Force Science Advisory Board and the President of the United States.

Dr. Brown is expected to take over his new job this spring. Dr. York, who was requested to stay with the new administration a few months, will take a post at the University of California.

## U.S. ICBM Force Now 18

Nine *Atlas* missiles in three complexes of the 565th. Strategic Missile Squadron went on operational status March 10—raising the Strategic Air Command's war-ready force of ICBM's to a total of 18. The 565th SMS is the second of three *Atlas* squadrons at Warren AFB, Cheyenne, Wyo.

## Aerie for Eagles

The Air Force is considering modifying KC-135 transport aircraft for use as *Eagle* air-to-air missile launchers.

The system under study by the North American Air Defense Command could operate autonomously or with other air defense units. Each plane could receive targets from its own sensors, other aircraft, surface radars or information centers such as SAGE.

*Eagle* is under development by Bendix for the Navy. The Boeing KC-135 jets, which would be called *Aerie* (eagle's nest), would carry more than two dozen missiles apiece.

## Navy orders 3000 Bullpups

The Navy has ordered approximately 3000 more *Bullpup* missiles from The Martin Co. at a cost of $14 million.

The price represents a 57.3% decrease per missile from prices when production began in 1958.

At the same time, a $1-million contract was awarded to Maxson Electronics Corp. of New York to second-source production of *Bullpup* guidance and control components.

## Big Booster Studies

North American Aviation, Convair Devision of General Dynamics and The Martin Co. will perform design studies of a liquid-propellant vehicle with booster thrust of 2-3 million lbs.

NASA's Marshall Space Flight Center last week awarded contracts of $163,040 to North American, $148,487 to Convair and $115,565 to Martin.

The vehicle would be based on the Rocketdyne *F-1* or possibly the LOX-hydrogen *J-2* in the booster stage. Upper stages would be nuclear or LOX-hydrogen.




**Rocket Sled Tests Navy Guidance**

*AEROJET-GENERAL'S supersonic rocket sled blasts off during recent tests of a guidance system at the U.S. Naval Ordnance Test Station, China Lake, Calif. Guidance is carried in nose section of sled in shot down the SNORT (Supersonic Naval Ordnance Research Track). Sled has total thrust of 84,000 lbs.*

## Orbital Launch for Rebound

NASA's Goddard Space Flight Center is asking for bids by March 31 on an 8-month design study of an orbital launching technique for Project *Rebound*.

The study calls for developing a method of launching 140-ft.-diameter passive communications satellites from a large orbiting satellite.

First launch in mid-1963 with an *Atlas Agena B* vehicle will be a spacecraft carrying three balloon satellites, each weighing between 400 and 1000 lbs.

Later in 1963, the plans call for launching 6 Balloons with a *Centaur* vehicle. The satellite may be in an elliptical orbit ranging from 1500 to 7500 miles, at an inclination of 45° to 90°. However, the balloons themselves must be in circular orbits perfectly spaced so that they will decay simultaneously.

Ultimate plans call for launching up to 12 *Echo*-type balloons from a single spacecraft.

## K: Watch the Russians

Russian Premier Nikita Khrushchev is "confident that the time is not too far off when the first (Soviet) spaceship with a man aboard will flash into outer space."

Khrushchev made the prediction following the second successful return of a Russian space vehicle containing animals. The Soviets said the vehicle, launched and returned March 9, landed at a preselected spot inside the Soviet Union. Two previous "Zooniks" were burned up in the atmosphere.

The ship contained a 14-lb. dog, guinea pigs, black mice and "other biological specimens." Moscow radio said the dog was "feeling fine."

The rocket booster apparently broke into two parts after ejecting the return capsule. Orbital data released by NASA on the fragments are: Theta 2, perigee 106, apogee 131 statute miles; Theta 3, perigee 107, apogee 118 miles. Both have an inclination, of 64.93°.

## EIA Wants Insurance Plan

Electronics Industries Assn. is pushing for Congressional action on a bill to provide Federal indemnification of missile/space components suppliers in case of damage to private property by missiles and space vehicles. Conceivably, the Government, prime contractor, and component manufacturer could all be held liable in such accidents. Small subcontractors are becoming concerned over possible risks involved which could ruin them financially. Legislation, first presented to the 85th Congress by DOD, has never gotten a hearing. EIA feels that considerable pressure from DOD will be required to get the bill introduced.

## Relay Bidding Starts

An advanced version of the Project *Relay* active repeater communications satellite will come up for industry competition this year.

The first *Relay* is an 85-lb. spacecraft to be launched with a *Delta* vehicle early in 1962 into an orbit ranging from 1500 to 2000 miles. The advanced version will provide for multiple launchings with an *Atlas-Agena B* vehicle into an orbit ranging from 5000 to 6000 miles.

The initial National Aeronautics and Space Administration program calls for two *Delta* and two *Atlas-Agena B* launchings.

## CEA Switching Name

California Eastern Aviation, active in missile tracking, impact detection and electronics devices, has asked its stockholders to approve a name change to Dynatronics Corp.

The company also announced a 5% stock dividend. Sales jumped from $90 million in 1959 to $125 million in 1960. Backlog was up more than 35% over the previous year end reaching over $25 million at Dec. 31.

Subsidiaries of Dynatronics Corp. are: Land-Air, Inc., Air Carrier Service Corp. and Aircar Engineering International Inc.

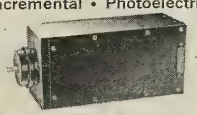
## Far Out for 30 Days

A second pair of Air Force jet pilots have embarked on a 30-day simulated space journey at the School of Aviation Medicine.

The subjects, Capt. Ramon A. Horinek, and 1st Lt. Eugene R. Carlson, will be maintained at an altitude of 18,000 ft. although they will breathe a greater concentration of oxygen. They will eat pre-cooked, dehydrated food and use recycled body water for drinking, cooking, and washing. ❋



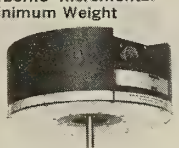

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# Limited War Cost Bind

## *Administration Plans Hit by Slowdown*

***Questions before Pentagon and White House: Can the cost-squeeze and ever increasing complexity of Missile Age weapons be reversed? If not, how big can limited war forces of Army, Air, Navy be built up? Military officials seek help from industry in reducing R&D, production and O&M expenditures.***

**by James Baar**

THE MISSILE AGE cost squeeze is putting a crimp in Administration and Army-Navy plans for a sizeable buildup of the nation's limited war forces.

The high pricetags on much of the increasingly complicated equipment needed for the buildup is resulting in a decrease, at least in the rate at which it will occur and possibly in its overall size.

Moreover, the cost squeeze is bringing renewed, fervent pleas by Army and Navy officials to industry to help find ways to reverse the trend toward complication and spiraling costs.

The problem seldom has been made clearer than this last week at a Defense Planning Forum held in Washington by the Electronics Industries Association.

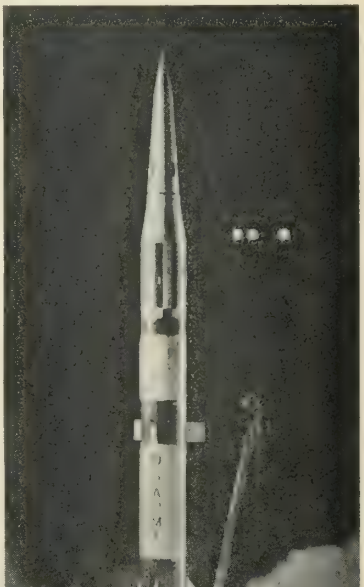
Rear Adm. J. A. Jaap, director of Navy development programs, put the matter bluntly by citing the cost of modern aircraft. He said that "an average airplane that would have cost $750,000 less than five years ago would, in its modern version, cost roughly $1.75 million today."

"In naval aviation we are losing airplanes at the rate of about 1200 a year as a result of wearing out, obsolescence, crashes and the like," he said. "But at today's prices we can replace these planes at a rate only a little more than half as fast as we lose them."

He made clear that the Navy is facing precisely the same kind of problem in its successive generations of missile systems.

• **Costly maintenance**—"As most of you know, we have some equipments in our ships today that are marvels of technical wizardry," Jaap told the hundreds of industry officials who crowded the big hall in a downtown hotel. "They are a delight for the designer, the builder and the contractor to behold and even we in the Navy point them out as the fanciest things that ever got into production. But we find they have one very significant defect. It takes a terrific amount of effort to make them work."

Hence, the admiral said, not only are such modern weapons highly expensive—their maintenance is equally expensive or more so.



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Just the routine maintenance thes items require is a challenge to th capabilities of a graduate engineer, he said. "It is a far greater challeng to the under-21-year-old youngster who make up about two-thirds of ou enlisted strength today."

Jaap said a major step toward re versing the cost and complexity tren would be for industry "to give reall serious attention to carrying out th aims of . . . *Project Kiss*"—the inven tion of Rear Adm. Paul Stroop, chie of the Bureau of Naval Weapons.

"*Kiss* unscrambled means 'keep i simple, stupid' (or, 'sir,' as the cas may be)."

• **Simplicity, please**—The sam theme ran through papers presente to the forum by an industry panel.

Welko E. Gasich, Northrop directo of advance systems, said a close sup port missile with a maximum range o 40 to 50 miles is needed. He said th missile probably would have a soli motor, and HE warhead and "shoul be as simple as possible for easy fiel operation and maintenance."

"For today's modern weapons th M&O cost account for between two thirds and three-fourths of the tota cost of a weapon system, and, hence are not to be considered lightly," h said. "In recent years, M&O costs hav climbed (so) that, for small nations the operation of complex weapon Sys tems is virtually prohibitive."

John F. Greco, requirements plan ner for Hughes Aircraft, said the suc cessors to *Sergeant* and *Pershing* in th late 1960's must have "less bulk greater reliability and accuracy, re duced maintenance and less prefirin checkout time . . ."

• **Trim paperwork**—A. Atley Peter son, senior Washington representativ of Sperry Rand, suggested that a firs step toward cost reduction would b

elimination of "needless paper studies."

"I believe every scientific or technological consideration has been duplicated at least once," he said. "Let's top high-pressure selling and prove ome of our ideas. This high-pressure elling exists within the government as vell as outside."

Peterson also suggested a sharp reluction in "paperwork for its own ake." He said that a recent military tudy showed that "documentation for 'Y '62 would approximate 15 to 35% f contract value."

Then Peterson touched on an extremely sensitive point.

"Looking back over the factors . . . or limited war, we see a desperate eed for planning," he said. "Instead f single-service approaches, we need n integrated approach. This does not nean a single service but rather a reexamination of the roles and missions. his in turn cannot be done without lanning at the top levels . . . to inegrate the political and the military."

Brig. Gen. R. C. Richardson III, hief of the Air Force's Long Range lanning Group, dug deeper at the ame point.

"There is an inter-relationship that xists today between the rapid changes roduced by technology, the costs of he new weapon systems and the conistency in our requirements for these," e said. "Our commitments remain elatively fixed, or else increase, or else . . costs for individual systems have een rising along with their effectiveness —though not at the same rate."

He said the result is that quantity f forces, commitments or military conepts have to be adjusted in order to revent the cost from ultimately overaking the Gross National Product.

Richardson made no suggestions or adjustments in military concepts. lowever, the implication of his reiarks clearly called into question the ossibility of meeting the Soviet Union r other Communist powers on the round in large numbers with conentional or only a small number of ictical nuclear weapons—a possibility ose to the heart of overall Army mited war planning.

Richardson also recalled that a rench general, when asked why the Vest persisted in thinking of fighting ars with nuclear weapons, commented:

"The Russians have more boots ian we have butts."

How much this line of thinking and ie cost-squeeze would affect Admintration plans for strengthening the ation's limited war forces remained to e seen in the coming weeks.

*(For a report on ARS, ASME meetgs in Los Angeles, See page 41.)*

*Limited War Needs*

# Role of Electronics to Grow

**by Hal Gettings**

ELECTRONICS will play an increasing part in the plans of all military services for limited-war capability during the next decade.

Primary emphasis will be on better, smaller, cheaper, and more reliable communications and related command control equipment.

Secretary of the Army Elvis J. Stahr, Jr. told the Electronic Industries Association defense market planning forum that command control—including communications, avionics, and combat surveillance—presents "more and greater challenges" to the electronics industry. In communications, he said, "we have a desperate need for both combat and global communications . . . with greater traffic capacity, greater speed, greater reliability, and more versatile facilities.

Stahr pointed out the developing need for new electronic equipment for Army aircraft—navigation, communications, flight control, identification, instrumentation—and the requirement for smaller and simpler systems.

He cited the growing importance of combat surveillance equipment for reconnaissance and weather information. Such systems must include electronic data processing for rapid assimilation and presentation of the gather information.

• **$6 billion market**—John F. Greco, Hughes Aircraft Co., said that the Army could be expected to spend at least $100 million alone for electronics for deep-penetration surveillance aircraft within the next ten years. Developments in this area will be divided among target acquisition, enemy detection, terrain and nuclear surveillance, and information processing.

Greco estimated the Army electronics market will total some $6 billion over the next decade. Over half of this ($3.07 billion), he said, would go for command control systems. Missile electronics will get $2.2 billion, air mobility $350 million, and "non-mission oriented research" $150 million. Limited war spending will peak in the 1966-67 period, Greco said, and gradually taper off toward 1971.

Brig. Gen. John T. Snodgrass, also speaking for the Army, called for increased research efforts by the electronics industry. He, too, stressed the growing importance of communications, surveillance, and command control functions in limited war. He said the increasing use of tactical radio and the lack of usable frequency spectrum calls for some real advancements in spectrum-saving techniques.

Refinements on present SSB and time-division pulse modulation techniques offer some hope, he said, but more research would open other areas. He mentioned the possibility of small tactical troposcatter systems and the need for a simple method of providing battlefield security for voice circuits.

Surveillance systems, too, Snodgrass said, offer a challenging field for electronics. He cited surveillance radar, high-definition data links, data processing and display equipment, and infrared and photographic sensors as real needs in the immediate future.

Speaking for the Navy, Rear Admiral J. A. Jaap, director of development programs, said the Navy's principal needs are improved navigation and station-keeping devices, new power sources, and an improved capability for detecting and disposing of enemy mines and submarines.

Electronics, Jaap said, will play a leading role in improving Navy tools for limited warfare. Advanced detection devices, automatic data processing equipment, and secure, reliable communications equipment with greatly increased traffic capacity are primary needs. Also, he said, we need "as yet undreamed of" equipment in the fields of electronic countermeasures and counter-countermeasures, and other phases of electronic warfare.

Brig. Gen. R. C. Richardson, USAF, said that the air activities of limited war impose new requirements on electronic and communication systems. Principally, he said, is the need to process, on a global basis, operational information on which to base command decisions and quickly assess developments no matter where the conflict takes place and whatever its size.

Next in importance is the ability to extend control of air operations with long ranges and use of remote bases.

Also, Richardson said, there will be a need for mobile tactical control and warning systems to operate in areas with very little in the way of facilities, power, communications, etc. Such equipment must be light, mobile, efficient, and able to be tied in with other remote bases or control and command.

Welko E. Gasich, Northrop Corp., also stressed the importance of reconnaissance and intelligence data acquisition and processing equipment. He said that equipment to handle these vital functions must be developed as total systems or combination of systems. ⌗

# Zeus Seen as Anti-Satellite Weapon

## *Meeting hears reports from Army, Navy, AF missile & satellite officials; honors awarded at Goddard Dinner*

NIKE-ZEUS could have an anti-satellite capability with but "little" modification.

Brig. Gen. David C. Lewis, director of special weapons in Army R&D, told the national Missile/Space Conference last week that minor changes could extend *Zeus* capability to 200 miles and major changes could extend the vertical range to 1200 miles. He said the longer range could be achieved by 1967 without interfering with full-scale production of *Zeus*.

Lewis told the conference, sponsored by the National Rocket Club, that *Zeus* is on schedule with every indication it will continue to move ahead on the program laid down four years ago.

Several critical problems must be solved, however, before the *Advent* 24-hour communications satellite can come into operational use. Lewis listed them as attitude control in orbit, station keeping in orbit and long life. He said low orbits are also planned in the *Advent* program.

The Air Force timetable calls for a new family of boosters to come into use about 1966. Maj. Gen. O. J. Ritland did not say whether the new booster family will be liquid or solid. However, John H. Rubel, Defense Department R&E Office, commented that the Air Force has a growing interest in solids.

Ritland said the post-1965 Air Force timetable also calls for a ballistic missile defense from a satellite platform, with the capability of killing an ICBM immediately after launch.

A Navy spokesman reported that navigational accuracy possible with the *Transit* satellite is in the range of 200-500 yards—"a ship's length." Rear Adm. Thomas F. Connolly, assistant chief, Bureau of Naval weapons, estimated the cost of a *Transit* receiver at about $10,000.

Later, Dr. Frank T. McClure of the Johns Hopkins Applied Physics Laboratory, said civilian craft could get accuracy to within a mile with equipment costing only $5000.

Dr. Harry Wexler, chief researcher, U.S. Weather Bureau, reported the eventual full operational weather satellite system will comprise six polar-orbiting *Nimbus* satellites and three *Aeros* satellites in 24-hour orbit. He said the cost of *Tiros* pictures was 17 cents apiece, comparable with the cost of conventional weather observations.

The three-day Washington conference wound up with the fourth annual Dr. Robert H. Goddard Memorial Dinner and the dedication of NASA's Goddard Space Flight Center in Greenbelt, Md. (see photo).

These honors were awarded at the Goddard Dinner:

–Edward R. Murrow, director, U.S. Information Agency, received the National Rocket Club Award, given by Washington Technological Associates.

–The *Discoverer* industry team of Bell Aerosystems Co., Douglas Aircraft Co., General Electric Co., Lockheed Aircraft Co. and Rocketdyne Division, North American Aviation, received the Nelson P. Jackson Aerospace Memorial Award, given by the NRC.

–William J. O'Sullivan Jr. of NASA, who developed the thin skin for the *Echo* balloon satellite, received the Astronautics Engineer Achievement Award, given by the NRC.

–Lockheed Aircraft Corp. received the Dr. Robert H. Goddard Memorial Trophy, given by MISSILES AND ROCKETS.

–Allen M. Lenchek, University of Maryland, received the Dr. Robert H. Goddard Memorial Scholarship Award, given by the NRC. ■



### Goddard Center Half Completed

*FOUR BUILDINGS of the eight eventually planned for NASA's Goddard Space Flight Center were open for inspection at dedication of the center last week. On a line in lower part of picture are No. 2, Research Projects Laboratory; No. 1, Space Projects Building; and No. 3, Central Flight Control and Range Operations Building. Above center is No. 4, boiler house building. Space is cleared at top right for construction of No. 5, Instrument Control and Installation Laboratory. Three more buildings are to be completed by 1962. Center is located at Greenbelt, Md. between Washington and Baltimore.*

# Manned Shot Awaits Extra Firing of Redstone

FIRST MANNED suborbital flight in the *Mercury* program is being held up for one more *Redstone* shot, possibly delaying a U.S. astronaut's first glimpse of space until May 1.

The *Redstone* carrying a dummy *Mercury* capsule may go in the next week or so. It will prove out several corrections in the booster which were made following the 130-mile overshoot of the chimpanzee-carrying *Mercury Redstone 2* on Jan. 31.

Timing of the manned *Redstone* flight, which had been expected in April, now will depend upon the success of the forthcoming dummy capsule shot and also *Little Joe 6,* which was scheduled to be fired this past week from Wallops Island, Va.

Dr. Robert C. Seamans, associate NASA administrator, told M/R a series of difficulties developed with the *Redstone* in the *MR-2*. He listed them as:

–Failure of engine thrust regulator.

–Excessive vibration in missile vanes.

–Capsule-booster dynamic instability.

–Electronic wiring design inadequacies.

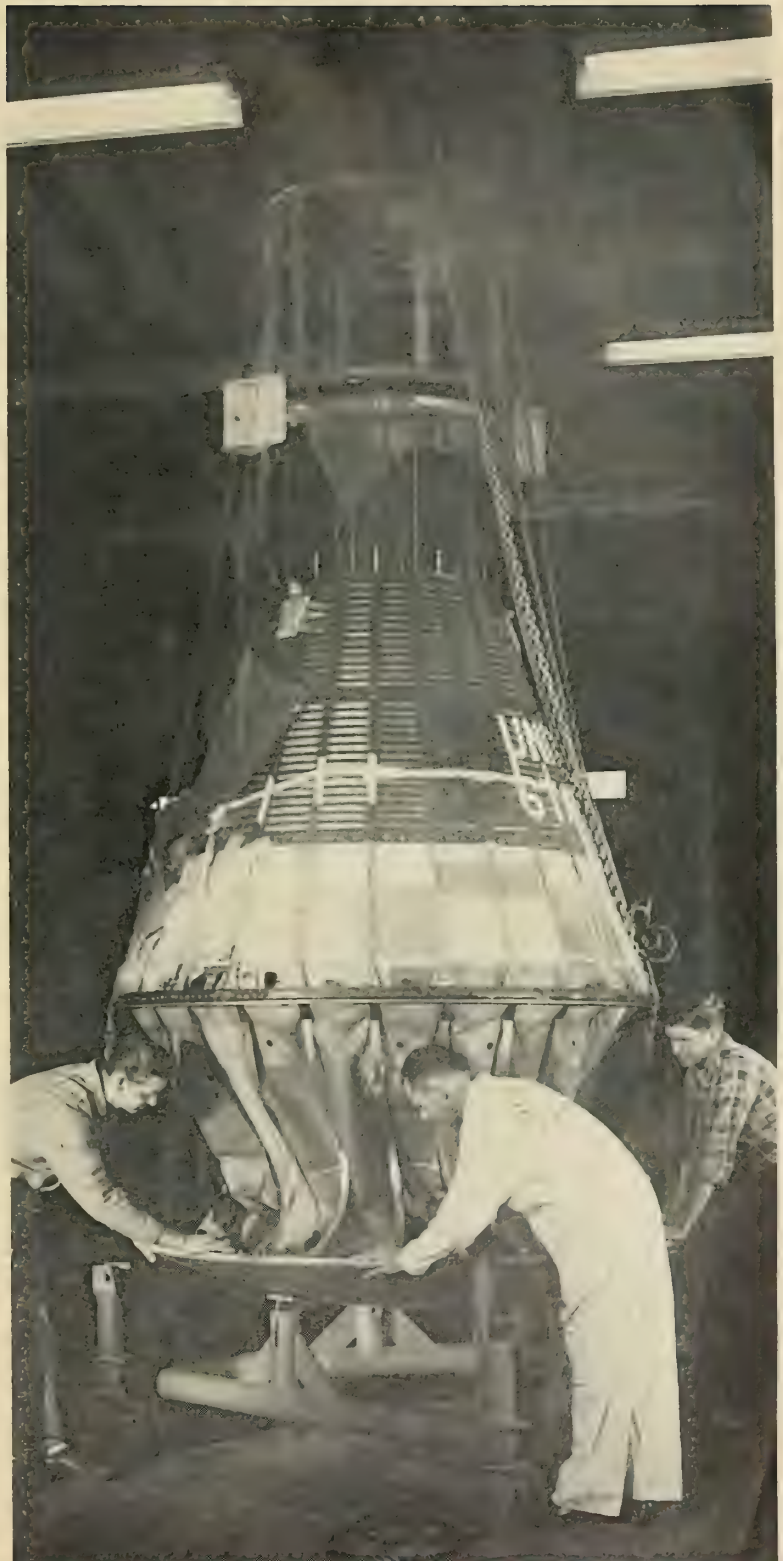
NASA decided to use a dummy capsule, Seamans explained, because it felt there was no further need to test the fully equipped and expensive capsule. Also, no attempt will be made to recover the boilerplate capsule.

The test will be designated *MR-BD (Mercury Redstone-Booster Development).* The first manned capsule will retain the designation *MR-3*.

Seamans said the additional *Redstone* shot will undoubtedly cause some delay in the manned launching. But he said the delay will not be great if the *Redstone* development shot is successful.

Meanwhile, NASA's Space Task Group went ahead with plans for *Little Joe 6,* which was to be the final qualifi-

*(Continued on Page 36)*



*NASA'S LITTLE JOE 6 spacecraft will include a 4-ft. rubberized landing bag, to open after parachute breaks out and serve as air cushion for landing.*

# NASA Begins Push for Big Solid-Fu

by Jay Holmes

***Ostrander hopes for an extra $15 million to be spent in FY '62; Webb starts review of budget; new program is possible***

THE BOSS OF launch vehicles in the National Aeronautics and Space Administration is publicly supporting solid propulsion for big boosters.

Maj. Gen. Don R. Ostrander told the House Space Committee last week he hopes $15 million will be added to the Fiscal Year 1962 budget to get going on the big solid. Recalling that President Kennedy asked NASA Administrator James E. Webb to make a thorough review of the U.S. space program, Ostrander said he had urged Webb to take another look at the possibility of increasing spending on solids.

Late last week, Webb and Deputy Administrator Hugh L. Dryden began what Webb described as a "systematic and somewhat formal review program," hearing proposals on revision of the previous administration's budget from directors of major offices within NASA. After completion of the formal review, Webb told the House committee, he expects to submit his findings promptly to President Kennedy. He said he already has decided he will recommend some budget changes.

Wernher von Braun, director of NASA's Marshall Space Flight Center, told the committee the Kennedy administration will seek increased funding for *Saturn* and *Centaur*. Ostrander explained that the *Saturn* money would go mainly for the *C-2* version of *Saturn*. The three-stage *Saturn C-1* is already funded, so that it could not be speeded significantly, he explained.

Ostrander said he also hopes to increase spending on liquid propulsion by $15 million in FY '62. Presumably, most of that would go to speed development of the Rocketdyne *F-1*, single-chamber LOX-kerosene engine with 1½ million lbs. thrust.

• **Specifics deferred**—Neither Ostrander nor Von Braun told the committee just how much additional money they sought. However, there are reports that requests for more than $140 million in the launch vehicle offices are pending before Webb and Dryden. Other NASA offices are also seeking increases, but those amounts have not been disclosed.

Ostrander told the committee NASA is funding United Technology Corp. to go ahead with the development of a 70,000-lb. solid segment for test firing by June or July. It was understood that the money still available in FY '61, will not pay the total NASA cost. Some of the payment will be FY '62 funds, available after July 1. The total amount of the contract was not disclosed, since it is still in negotiation. However, it will provide for sharing of costs between UTC and NASA.

The current NASA plan calls for following up the single UTC segment firing with the development of a two-segment test motor generating about 500,000 lbs. However, if President Kennedy and Congress approve Ostrander's request for an additional $15 million appropriation in solids, a separate program will begin for the development of a segment in the 100,000-110,000-lb. weight class.

In such a case, NASA would go out to industry for bids on the separate program. The initial contract would call for development of the single segment over the course of FY '62. However, the big segment development might well lead into a five-segment motor of total impulse comparable to the 1½-million-lb.-thrust *F-1*.

The single segment would develop upwards of 400,000 lbs. thrust for 60-70 seconds. A rocket made up of five such segments would develop something over 2 million lbs. thrust for the same duration—approximately comparable to the work load envisioned for the *F-1*.

• **"Difference of semantics"**—O trander told the committee the maj advantage of a solid booster is th the unit cost will be lower than for comparable liquid rocket. Howeve Von Braun cautioned that there are r short-cuts in the process of developir a reliable rocket.

Rep. Overton Brooks (D-La. committee chairman, asked the Hunt ville chief about a statement by Thi kol Chemical Corp. that a solid rock of 2-3 million lbs. thrust can be deve oped in 18 months.

"There is a difference of sema tics," Von Braun replied. "No doub they could build a rocket in 1 months. But when we look at the pai ful process of getting any rocket in condition of operational readiness, w know that the time involved is longer

Brooks asked whether Von Brau thought the claim too optimistic.

"Yes, sir," Von Braun replied. "W have to go through a painful proce of checking, to make rockets mo reliable."

• **Much interest, little money**—A this point, Ostrander interjected, "W in NASA are extremely interested i the large solid-propellant rockets."

The launch vehicles director w asked why there is such a great di proportion between NASA's projecte spending for liquid and solid propu

## Box Score, U.S. Orbital and Earth Escape Launches

| Vehicle | Launch Attempts | Successful Launches | Batting Average |
|---|---|---|---|
| VANGUARD | 11 | 3 | .273 |
| JUPITER-C | 6 | 3 | .500 |
| THOR-ABLE | 7 | 3* | .429 |
| JUNO II | 8 | 4* | .500 |
| ATLAS | 1 | 1 | 1.000 |
| THOR-AGENA A | 15 | 10 | .667 |
| ATLAS-ABLE | 3 | 0 | .000 |
| THOR-ABLESTAR | 6 | 4 | .600 |
| ATLAS-AGENA A | 4 | 2 | .500 |
| THOR-DELTA | 3 | 2 | .667 |
| SCOUT | 2 | 1 | .500 |
| THOR-AGENA B | 6 | 5 | .867 |
| TOTALS | 72 | 38 | .528 |

** Pioneer I and Pioneer III rated as successful, although the failed to reach escape velocity, because both rose to altitude of more than 60,000 miles.* Box compiled by M

# oosters

sion in FY '62. The Eisenhower budget calls for $68.7 million in liquid propulsion and $3.1 million in solid propulsion.

"We have inherited a number of launch vehicles from the military," Ostrander replied. "Also, the military is doing work on solids that we don't want to duplicate. But in view of its rapid advances, I believe we will want to increase our solid propulsion budget and I will ask Mr. Webb to take this into consideration."

Von Braun told the committee:

"You gentlemen can rest assured that whenever large solid or nuclear propulsion systems reach the state of maturity to become really competitive in this race for an economical space transportation system, we shall certainly take advantage of them."

• **Other voices**—Ostrander and Von Braun appeared before the House committee at the conclusion of a week of hearings on the nation's booster program. Industry spokesmen made these points in earlier hearings:

Samuel K. Hoffman, president, Rocketdyne Division, North American Aviation—Performance of solid-propellant systems is not sufficient to accomplish space boost missions as effectively as liquid or nuclear systems, which he said are a natural outgrowth of liquid propulsion. He recommended acceleration of the *F-1* engine, which he said is operating on a five-day week, with less than 2% overtime. He urged concurrent development of a vehicle around the *F-1*.

–Dan Kimball, president, Aerojet-General Corp.—A large segmented solid rocket could be developed in two to three years. He also urged increased work on large, efficient pump and pressure-fed liquid rockets, development of nuclear rocket technology for space, augmenting of work on booster recovery schemes to allow repeated use of large liquid boosters and continuous high-level support of R&D to advance propulsion technology.

–Dr. Harold W. Ritchey, vice president, Thiokol Chemical Corp.—His company can produce and deliver within 18 months a solid booster capable of generating 3 million lbs. thrust at costs comparable with liquid-propellant rockets. Some NASA officials are interested in his plan but there has been no official go-ahead. A cluster of seven such units, in combination with selected nuclear and electric propulsion stages, could allow cargo and transport flights to all parts of the solar system in the 1970 time period.

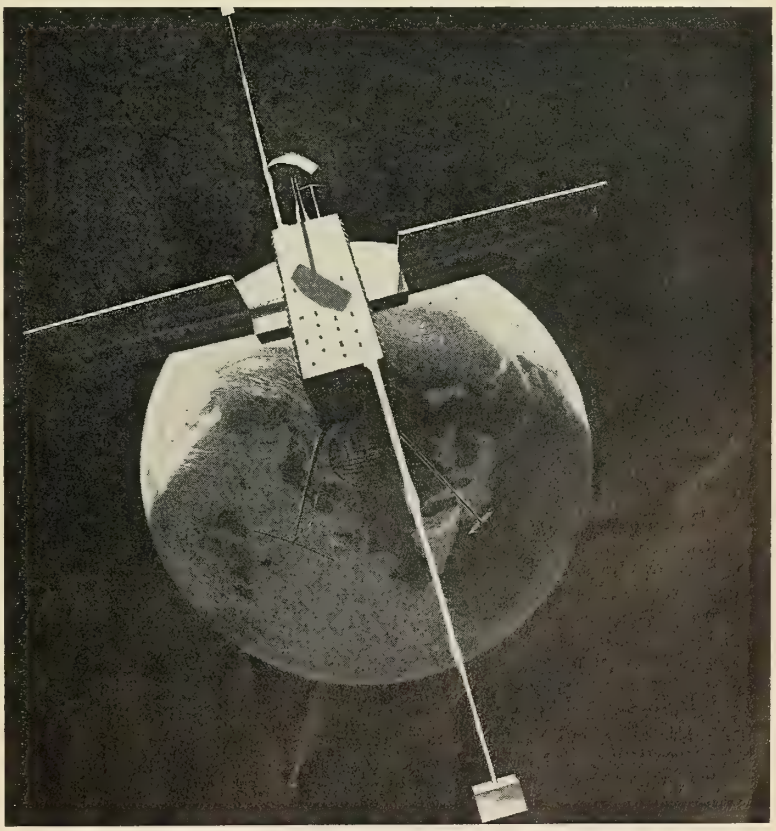
–Dr. Barnet R. Adelman, vice president-general manager, United Technology Corp., a United Aircraft subsidiary—His company is developing with its own funds a family of low-cost solid boosters that will permit the firing of the world's largest flight-weight solid rocket in the fall of 1961—with thrust of 500,000 lbs. for 60 seconds. Adelman apparently referred to the combination of two 70,000-lb.-weight segments under the cost-sharing arrangement with NASA mentioned above. He said the program could lead to an engine of 2 million lbs. thrust by 1964.

–William B. Bergen, president, The Martin Co.—Concentrate first on the liquid booster for large first stages. Apply any money left over to the solid booster. If the military is ever to have a more useful weapon than the ICBM, it will require new boosters. There should be a single U.S. booster technology, but differing civilian and military objectives will result in requirements for differing boosters for the two departments.

–J. R. Dempsey, manager, Convair Astronautics—The Air Force will require a workhorse booster of 800,000 to 1 million lbs. thrust, with special attention paid to low cost and simplicity. He urged a timetable for booster capability "plateaus" as follows: 20,000-30,000 lbs. in orbit in the next few years; 200,000-250,000 lbs. in orbit in 7 to 12 years; lunar base capability thereafter. ⁂

*The cigarette lighter and the match illustrate the difference between liquid and solid propellants, Dr. Wernher von Braun told the House Space Committee last week.*

*Von Braun said the example shows there is a need for both kinds of propulsion, depending on specific mission requirements.*



## Orbiting Geophysical Observatory

*NEWLY RELEASED conception by Space Technology Laboratories artist of NASA's Orbiting Geophysical Observatory (OGO)—the so-called "streetcar satellite" for which STL is prime. The first 1000-lb. OGO is scheduled to fly in 1963.*

*By Siddeley, SEREB . . .*

# Joint U.K.-French Effort Proposed

***Plan costing $150 million would include nuclear defense against satellite attack; official blessing apparent***

**by Bernard Poirier**

TWO OF THE MOST powerful combines in the European missile/space industry have offered a five-year, $150 million package to the British and French governments.

Involved are proposals on nuclear payloads, large rocket vehicle requirements and earth satellites—each to have Anglo-French designs. The military proposal again pinpoints NATO's modern ailment—the whole not having the military capability of its parts.

Britain's Hawker Siddeley Group and France's IRBM Agency, SEREB, conducted a joint study for several months before making these formal proposals backed by a 150-page Aerospace Report.

The two governments are asked to join in a $150-million effort which precludes U.S. participation but leaves the door open to other European nations who are willing to pay their way. The British share reportedly will be 51%, France 49%, unless others participate.

While the official announcement alluded only briefly to modern NATO requirements, informed M/R sources in Europe said the military anti-orbital-missile project could involve 1700-lbs. nuclear payloads designed to destroy enemy "nuclear rain" satellites by proximity detonation in the silence of outer space.

If Britain and France agree to this project, the latter will enjoy a political breakthrough in the Big Three Nuclear Club barrier, although most experts consider France a self-evident member of a Big Four Nuclear Club.

Other proposals, with less political impact, call for Civil Communications Satellites, *"Transit"* Navigation Satellites, propulsion, materials, lightweight structural research and electronic miniaturization development.

• **Homemade deterrence**—The companies attached much importance to the proposals "in these times of economic competition." However, one informed source described the feeling that France and England must get into space soon, on their own, or pay the premium later for the right to share in American know-how.

The Hawker Siddeley/SEREB study, believed to have started during the Eisenhower Administration, echoes widespread opinion that Western Europe should develop missile/space deterrence on its own. France is already committed to a multibillion-dollar strike force (M/R, Feb. 6, p. 40).

Moreover, several recent British proposals for European space cooperation could not have made any headway without a semblance of official blessing, which, at the very least, was not withheld.

The two industrial giants said "The anti-satellite project illustrates current trends in military thinking and it may become of great significance in future NATO defense plans."

The British group controls seven aviation and missile companies, the largest single group in the Commonwealth. The government controlled SEREB Agency, Société pour l'Etude et la Réalisation d'Engins Ballistiques, is the ballistic weapon system manager. Its shares are held by Nord, Sud, SNECMA, ONERA, G.A.M. Dassault, MATRA and SEPR.

Their reference to NATO plans is, at very best, a diplomatic understatement. The problem of anti-satellite defense is at least four years current and was described in 1958 by U.S. Lt. Gen. J. M. Gavin and by Russian Maj. Gen. G. I. Pokrovskii.

Also, the recent Soviet Venus probe (M/R, Feb. 20, p. 13) prompted immediate Congressional testimony describing the threat of military satellites as more imminent as the result of this Russian experiment.

Politics, like education, has had difficulty keeping pace with space evolutions. America's largest allies in NATO have become particularly impatient in the last year for some integrated NATO projects in this area.

Absence of political agreement has prompted these allies to consider several mutually beneficial projects, such as the recent Strasbourg Satellite Booster project (M/R, Feb. 20, p. 36).

Many British and French strategists feel Western Europe must have a nuclear/space capability. This can be obtained within or without NATO. The requirement, they feel, is necessary despite the costs involved.

• **Avoid "re-invention"**—It is precisely this problem of developing such European capabilities outside NATO which caused Paul-Henri Spaak, former NATO Secretary General, to declare last December: "The West is wasting its wealth . . . when . . . Allies are spending tens of thousands of millions merely to re-invent things which already exist."

His assertion would not have condemned a project such as the Hawker Siddeley/SEREB proposal but would have asserted that the Western Alliance was remiss for not having responsive political capacity to provide modern military requirements needed in the 1960's which had not been foreseen at the time the Treaty was drawn.

In the absence of any NATO agreement fulfilling needs outlined by Gen. Norstad in Rome and in Paris, the U.S. may see many opportunities to have a voice in international space/nuclear deterrence projects slip between its fingers.

Both Hawker Siddeley and SEREB recognize some European limitations for programs as have been or will be attained by the U.S. However, they feel there has been enough delay on two counts: determining which space and military projects are attainable with European resources and building up the state-of-art before the U.S. space effort gives American industry too great an advantage over European industry.

Sir Roy Dobson, Managing Director of Hawker Siddeley Group, said, "From an industrial point of view we feel that initially an evaluation must be made of projects within the scope of Western European capability."

It was further revealed that the Anglo-French industrial study was conducted in order to evaluate the space potential of Western Europe. Membership may be open to other Western Europeans but several pointed references were made to the European character which will prevail in any final organizational structure. ⠿





***at work on a approach to the***

As principal instrumentation contractor for Project Rover, EG&G is already at grips with the central problems of nuclear propulsion for deep outer space exploration. A control, instrumentation and data acquisition system designed and operated by EG&G is of basic importance in the full-scale testing of Rover's KIWI prototype engines, designed by the Los Alamos Scientific Laboratory. The EG&G system is being effectively applied to the solution of problems of heat transfer, neutronics, fluid dynamics and general control.

EG&G instrumentation is also at work in the application of nuclear energy to industrial uses (Gnome) and in the international program for detection of nuclear explosions (Vela). In oceanography, EG&G equipment is probing the ultimate ocean depths.

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**Said Johann Kepler:** *"The planets move in elliptical orbits about the sun, and the square of their periods of revolution are proportional to the cube of their mean distances from the sun."*

With interplanetary voyages fast becoming a reality, complete information regarding the velocity requirements for travel between planets is of vital importance. With these data available, it is possible to analyze propulsion requirements, plan ultimate system configurations, and conduct feasibility studies for any particular mission.

Lockheed Missiles and Space Division scientists have actually evolved a rapid-calculation method, utilizing a high-speed computer. This has produced literally thousands of orbits, velocity requirements, and elapsed time, for design studies of trips to and from both Mars and Venus—every tenth day from now until January, 1970.

More simple to analyze are many factors which make Lockheed Missiles and Space Division a wonderful place to live and work. Located in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, Lockheed is Systems Manager for such programs as the DISCOVERER and MIDAS satellites and the POLARIS FBM. These, together with research and development projects in all disciplines, make possible a wide diversity of positions for creative engineers and scientists in their chosen fields.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-14A, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

**Lockheed** / **MISSILES AND SPACE DIVISION**

*Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Program*

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

# Technical Countdown

## ELECTRONICS

### 10-Year Guidance Trends

As inertial guidance system characteristics change during the next decade or two, cost and production trends will change significantly, according to industry estimates. In moderate production, typical unit costs will drop from present $400,000 to $100,000, and development time is expected to be reduced from six to two years. During this same period system weight should drop from 300 to 50 lbs., cold-start response time decrease to 5 minutes, and reliability increase to 3000 hours MTF.

### New Scatter Circuits Operational Soon

Tropospheric-scatter telecommunications continue to burgeon. First BMEWS telephone circuits, using this propagation mode, are now being tested by the Air Force between Clear and Fairbanks, Alaska. These employ the first four of 34 stations using microwave and troposcatter which Western Electric is installing in the Alaskan region. The Clear system is due to become fully operational this summer. Other circuits will augment White Alice Communications System for NORAD.

### Existing Scatter Circuits to be Expanded

Pioneer in the scatter field, Page Communications Engineers, recently received a channel-expansion contract from the Navy to double its Iceland Troposcatter system capacity, and another from the Air Force to study means of increasing channel capacity on its North Atlantic Ionoscatter system. Proof of performance on AF program results will be demonstrated over an experimental circuit between Stoney Pt., N.Y. and Carrabelle, Fla.

### Big Scatter Dish Mobilized

A 30-ft. mobile troposcatter dish antenna has been developed by Antenna Systems, Inc. The self-contained assembly is carried in a flat-bed trailer. Mesh or solid paraboloidal surfaces are available, its developers say, and unit can be operated under normal wind loading without guys.

## OPTICS

### CCTV Amplifiers Cited for Astronomy

Closed-circuit television-type optical amplifiers offer better detectivity for astronomical purposes than conventional photographic systems or image converters. These findings were reported recently by Aeronautical Research Lab of the AF's WADD, following its investigation to find equipment limits for detecting very faint stars in the presence of the sky background.

### Ten-Magnitude Increase for Star Detection

The theoretical possibility that 34th-magnitude stars can be photographed using an intensifier image orthicon for nighttime observations is advanced in a current report by AF Research Division, WADD. This would be a 10-magnitude increase, since the faintest celestial body ever recorded with an image device was a 24th-magnitude star obtained with the Mt. Palomar 200-in. reflector. Key to such an increase, the Air Force says, is use of a storage target plate with capacity to hold and integrate charge image for at least 80 minutes with negligible loss of resolution or charge.

## ADVANCED MATERIALS

### U.S., Russia on Free Radical Par

The Russians have not made any significant advances in free radical chemistry beyond our own efforts in the field. A Government survey concludes that the Soviets are either not interested in free radical stabilization, or they are so interested they are keeping it a secret.

### Boeing Casts Titanium Alloys

A commercially feasible process for the production of titanium alloy castings using rammed and machined graphite molds has been developed by Boeing for the Air Force's Air Materiel Command. A procurement specification, quality control procedures, inspection standards and design criteria were also established.

### Navy Perfects Glass Tensile Tester

A hydraulic ring tensile tester which ruptures reinforced glass hoops is being used to develop a much-needed collection of quality control data. The information is often directly applicable to the design of large motor chambers. The instrument was developed at the Naval Ordnance Laboratory, White Oak, Md.

## SUPPORT EQUIPMENT

### Another Checkout Contender

Lockheed's Georgia Division at Marietta is moving into the GSE business with a contract for about $350,000 worth of checkout equipment for *Saturn*, under a contract with NASA's Marshall Space Flight Center.

### Tape-fed Machine Produces Atlas Parts

*Atlas* missile parts are being turned out automatically at Convair by a "machining center" which receives instructions on punched tape. The device is a Kearney and Trecker Milwaukee-Matic Model 2, which selects 31 tools in any sequence from a storage magazine.

## PROPULSION

### Polaris Not For Shore Use?

*Polaris* can't be adapted to Army use because it can't withstand the shock and wide temperature ranges involved, says Dr. Wernher von Braun. He said the Navy gave priority to high $I_{sp}$ rather than shock and temperature resistance in *Polaris*, because requirements are easier aboard nuclear submarines, where there is plenty of power available to air-condition the missiles.

## ASW ENGINEERING

### 300-Ton Hydrofoil Award Due Soon

Proposals for the AGEH (Hydrofoil Research Ship) will be due into the Navy's Bureau of Ships early in April. Invitations to bid for the 250-to-300-ton-displacement vessel went out the first week in January. If Congress approves the concept, the award will be made this summer.

### 15-Ton Hydrofoil RFQ's Next

Another BuShips bid request will go out early this spring for a supercavitating R&D hydrofoil of about 15 tons displacement. The ship will be used as a test bed for power transmission systems and possibly for boundary layer control of the propeller.



America's FIRST man into space will rely on a Honeywell designed and developed Attitude Stabilization and Control System for controlling his space capsule. This system automatically damps out initial launch rates, orients and maintains the capsule in proper orbital plane, and provides for the correct descent trajectory and re-entry angle. This device is just one of the many contributions being made by Honeywell scientists and engineers to our nation's space programs.

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# Air Seals: Missilemen's Key to Life

***How unique blast closure valves with response time of 2/5 second were developed to protect sites from nuclear attack***

**by William Beller**

THREAT OF SURPRISE nuclear attacks is driving the allowable response time of some ground support equipment below one second, for hardened ICBM sites.

The most critical GSE components from the viewpoint of the launch personnel—parts whose rate of response could determine whether the personnel survive the attack or die—are the seal mechanisms through which ventilating air passes. These are the mechanical seals in the ducts that lead from above ground to the major compartments of the missile facility: the silo crib which holds the missile, the underground launch control center, and the entry tunnel which runs between them.

The seals have a simple purpose: to close quickly when an attack is pending; to open when the danger is over.

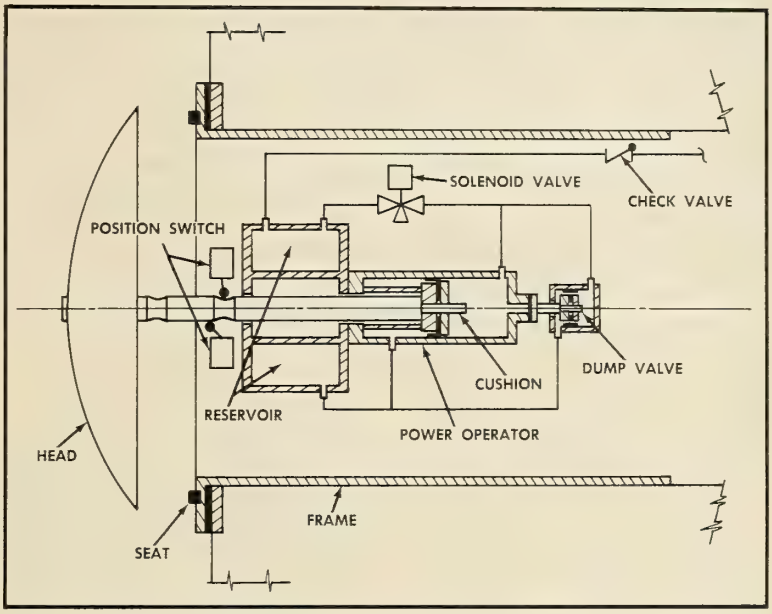
There are eight such seals. Their response times are one-fifth of a second or better. The two larger seals are 3½-ft. in diameter. They are all stressed to 200 psi overpressure, sufficient to resist a 10-megaton nuclear bomb exploding one mile away.

• **A unique design**—When studies first started on the design of these blast closure valves, there were no applicable engineering data. Of course, designers had had experience with relatively small, slow-acting valves, but not with the fast-acting, large ones needed now. As a result, basic design criteria were set up early in the development program.

These called for blast closures capable of (1) closing rapidly, and positively, (2) resisting anticipated blast and shock effects, (3) maintaining a positive seal during closure, and (4) operating reliably under rigorous environments and infrequent cycling.

The designers decided that a pneumatically-powered mechanical system would be the most reliable. They also agreed that the closure door should be on the same shaft as the power operator or piston.

Since a piston was to be used, and since it had to be fast-acting, the static




*BLAST CLOSURE SCHEMATIC shows how dump valve pilots the power operator.*

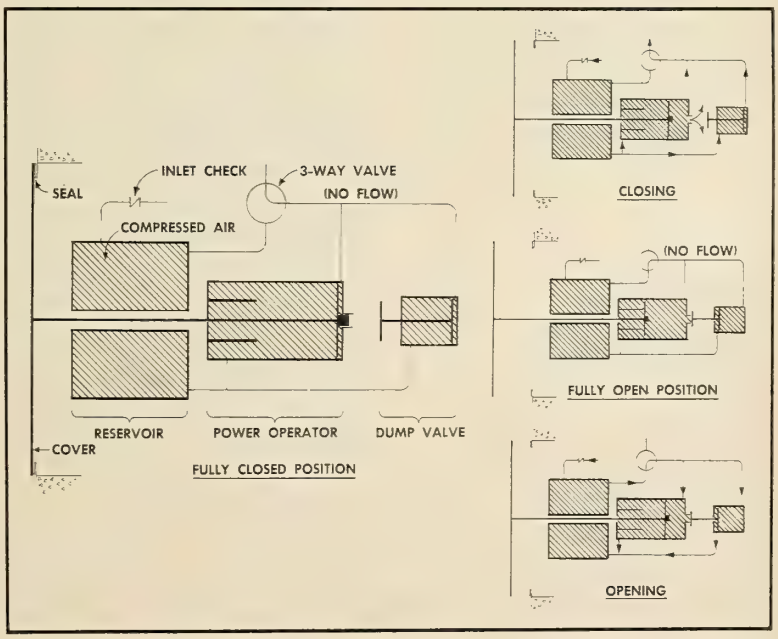
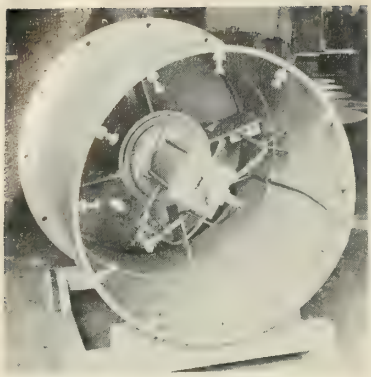



*DIAGRAM TRACES COMPRESSED air flow during closing and opening operations.*



*CLOSURE MECHANISM for seal shows dump valve atop tower operator.*

friction problem eliminated many of the materials commonly used for seals and packing. Yet, some of the fluorocarbons did show some promise; and Teflon was tried. The engineers now report that this material has for all practical purposes "eliminated the friction problem within the temperature and pressure limits of the design."

Here is how the blast closure works, starting from the normally open position to the fully closed one:

1) The solenoid valve is de-energized, thereby disconnecting the compressed-air reservoir from the blank ends of the power operator and the dump valve.

2) At the same time, the blank ends are connected to the exhaust through the newly positioned solenoid valve.

3) As a result, the pressure in the blank end of the dump valve's relatively small volume decreases rapidly.

4) Thus, the dump valve moves quickly and exposes the large orifice at the blank end of the power operator.

5) Fast exhaust takes place at the blank end of the power operator; then, with the accelerating force of the compressed air in the reservoir acting on the rod end of the power operator, the closure seal is drawn to its fully closed position.

6) A pneumatic cushion softens the homing of the seal.

When the procedure is reversed, the blast closure is opened.

Although the specifications and use of these valves are highly exotic, the design is essentially simple. It is a variation of the basic poppet valve, using an elementary circular seal, standard linear motion dynamics.

The closure valves were designed and developed under the direction of the Air Force's Ballistic Missile Division. Participating members of the contracting team included the Bechtel Corp., Henry Pratt Co., and Armour Research Foundation of Illinois Institute of Technology. ⁂

# Nuclear Space Transportation Seen Feasible Within Decade

## *Douglas' Johnson tells Congress of four-step plan for total system; argues that cost is justifiable*

NUCLEAR-POWERED transports that are recoverable and re-usable can be developed within 10 years, and the nation that gets them first will dominate space, a leading missile/space engineer told Congress recently.

This is the real opening of the "new frontier," R. L. Johnson, chief engineer of Douglas Aircraft Co.'s missile and space systems, told the House Committee on Science and Astronautics. He declared that nuclear power "for economical space transportation is a far different operation than the current marginally justified (non-nuclear) program."

A vigorous nuclear transport development program would solve an entire class of space transport problems simultaneously, Johnson said, and therefore should be given a degree of funding which is substantial compared with that committed to any of the other systems which are by nature suited only for limited—for example, orbital —operations.

The nuclear transport is expected to serve three functions: (1) a truck device carrying objects into and out of orbit; (2) a lunar round-trip transport, and (3) an interplanetary exploration and transport vehicle.

"The vast possibilities of space, either for military or other applications, will only be scratched until an effective transport is operational," Johnson told the Committee.

He explained that by "effective" transportation systems "we imply economy of operation, convenience in terms of travel schedules, ease of maintenance and versatility of utilization.

**• Justifiable costs**—The Douglas engineer maintained that if a proper device is used space transportation is not expensive.

Based on an already demonstrated specific impulse, said Johnson, the lunar-cargo transport cost of the reusable rocket is only slightly more than ten times the cargo transport cost for cargo delivered halfway around the earth by DC-8. "Compare this with the costs associated with non-reusable chemical systems of more than 500 times the DC-8 unit cost," he advised.

These are only the direct operating costs. Johnson estimated that probably over a billion dollars might be needed to build reusable nuclear engines of the reliability needed for its work. Granting that this is a large amount of money, he observed that it is "not particularly different in magnitude from the development price required to bring about the jet-engine revolution in aircraft, or the development of large liquid chemical engines."

He calculated that for a nuclear-engine development price of a billion dollars, less than 400 tons delivered to the moon would completely amortize the development price of the nuclear vehicle.

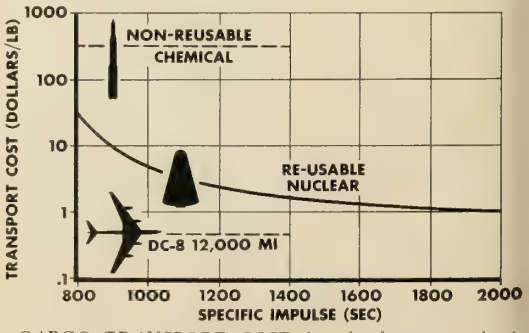
**• Four-stage program**—Urging that a total nuclear transport system be developed, rather than merely a nuclear rocket system, Johnson proposed four steps to bring this about.

First, there should be early work on recovering vehicles specifically designed for the nuclear transport mission.

Next, the *Rover* engine, for which a competition is now being held, should be used in a suitable ground and *Saturn* flight-test program. The experience gained here would be useful in solving the transport problem.

Third, the engine developed under the *Rover* program should be upgraded to the 200,000-lb.-thrust class; there must be improvements in its specific impulse and thrust-to-weight ratio.

Finally, when a cluster of four of these engines is available—or there is a single engine of about 750,000 pounds thrust—a nuclear-powered space transport should be designed. ⁂




*CARGO TRANSPORT COST for the lunar round trip.*

# IR Transducer Brings New Advantages

***Electro-Optical unit offers way to detect and resolve radiation at minute angles, can be aimed electronically***

**by Charles D. LaFond**

A NEW INFRARED transducer now in advanced development promises to aid greatly in a whole range of detection, measurement, and even guidance and communications applications.

An outgrowth of the Radiation Tracking Transducer (RTT) announced last year by Electro-Optical Systems, Inc., Pasadena, Calif., the unit has similar characteristics but responds to radiation in the intermediate and far IR range (3-6 micron wavelengths).

The early RTT employed a silicon cell offering a sensitivity range in the visible-to-near IR spectral range (0.5 to 1.1 microns). This and the new cell, which uses indium-antimonide (InSb) in a cryogenic environment, employ a lateral photo-effect associated with illuminated semiconductors to measure radiation intensity with microsecond response time.

Its developers feel that these detectors can provide characteristics not available in more conventional optical tracking or measuring sensors:

– Units are capable of detecting and resolving angular position of light or other forms of radiation (depending on the detector material) at angles of motion smaller than 0.1 second of arc.

– Cells can be aimed electronically, thus making mechanical rotation unnecessary (permitted by the use of wide angle optics in the telescope configuration).

• **Background**—The original RTT was developed for the Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Ala. This device is now being manufactured and marketed by Micro Systems, Inc., a subsidiary of EOS in San Gabriel, Calif.

Both the InSb and the silicon cell detectors are used with standard x-y recorders to give accurate position data in one plane along one or two axes.

The new IR responsive units have been under development at EOS for the past 9 months as a company-sponsored project.

• **Lateral effect employed**—The RTT employs a light-spot position solid-state transducer. Essentially a two-dimensional output device, it consists of a broad, thin p-n junction having two pairs of connections on the n-layer.

When illuminated by a radiant source within its response range, the p-n junction experiences the development of a voltage proportional to the radiation intensity. This is a much-used photovoltaic effect.

However, the illuminated p-n junction also develops a lateral photovoltage in the presence of non-uniform radiation. This voltage changes in amplitude and in phase as the illumination transverses the photocell surface. This is the lateral photo effect discovered by J. T. Wallmark of RCA and first reported in April, 1957.

For spot displacements up to ± 20% of cell diameter, the lateral voltages (two directions) can be made proportional to the x-y displacement of the light spot with reference to the cell center of symmetry—(x, Y) and ($V_x$, $V_y$) all equal zero.



*INFRARED RADIATION tracking transducer (RTT) under development by Electro-Optical Systems, Inc., senses angular position to 5 microns in microsecond response time. Indium-antimonide cell (arrow) is housed here in liquid nitrogen dewar.*

In the EOS silicon-cell configuration, the p-n junction employs a low-resistivity p-layer and a high-resistivity n-layer. Under illumination, hole-electron pairs are developed in both regions, but the field at the junction sweeps the holes into the p-region and electrons into the n-region. Electrons spread out laterally and recross the junction because of the radiation-supplied forward bias. Potential distribution in the n-layer is radially symmetrical about the light spot and can be calculated.

Cell output is proportional to both the intensity and the position of the illuminating spot. Tests have shown that the measured effect of several spots is the linear superposition of the effects of all the individual spots. Thus, EOS states, the cell will respond to the "center of gravity" of a general intensity distribution on its surface.

More simply stated, the output generated by a single spot against a uniform background equals that of the spot alone. With a single spot and a non-uniform background, cell output is a function of the spot position and background configuration.

Many improvements have been made since the first RTT was developed. Voltage drifts with time have been measured for long periods at room temperature. Originally these ranged from 2.5-3.5 mils over several days, but this has been improved by a magnitude, says EOS.

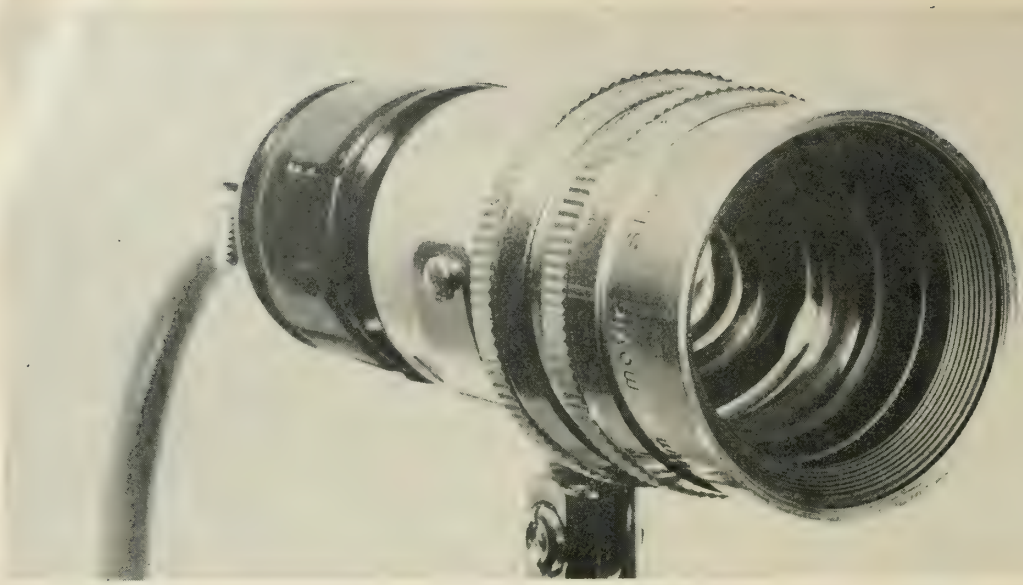
Drift amount to 1% of a 0.280-in. full scale is now down to 0.05-0.1%. This was achieved largely by hermetically sealing the cell.

However, without significant increase in uniformity of the semiconductor body, EOS feels non-linearities of 7% of full scale remain a limit for linearity improvement.

• **Range extended**—Current efforts by EOS to extend spectral response have centered on the use of indium-antimonide. Units now under test respond to infrared wavelengths from 3-6 microns.

Other semiconductors with special doping are being studied for use in 8-14 micron range.

InSb detector temperature of 77°K



*SILICON RTT, developed originally for the Army, is shown with mounted lens system. Responsive to visible and near-IR illumination, it is adaptable to tracking, instrumentation, and even computer techniques. New cell uses indium-antimonide.*

(liquid nitrogen) was employed early in the investigations, but with improvements in sensitivity liquid carbon-dioxide cooling (195°K) has been used successfully.

Two principal designs have been used. One is essentially the same as that used in the silicon cell; that is, it employs low resistivity in the n-type base device. The other uses a high-resistivity, n-type base, but radiation is received by the p-layer of each to take advantage of the longer diffusion length of electrons as the minority carriers.

Both responsivity and detectivity have been found lower in the first design. While the second configuration appears clearly superior, fabrication of cells so far has followed that of the first design. Available materials and junction-forming techniques are only suitable for that structure, according to EOS.

A development effort now underway has been concentrating on new approaches to fabricating the second design.

Units fabricated for test purposes to date have used a thin wafer of n-type InSb with the p-n junction produced by diffusing zinc from the vapor phase into the material

The finished cells are 0.015-in. thick and the ohmic contacts on the n-layer are 0.200 in. apart.

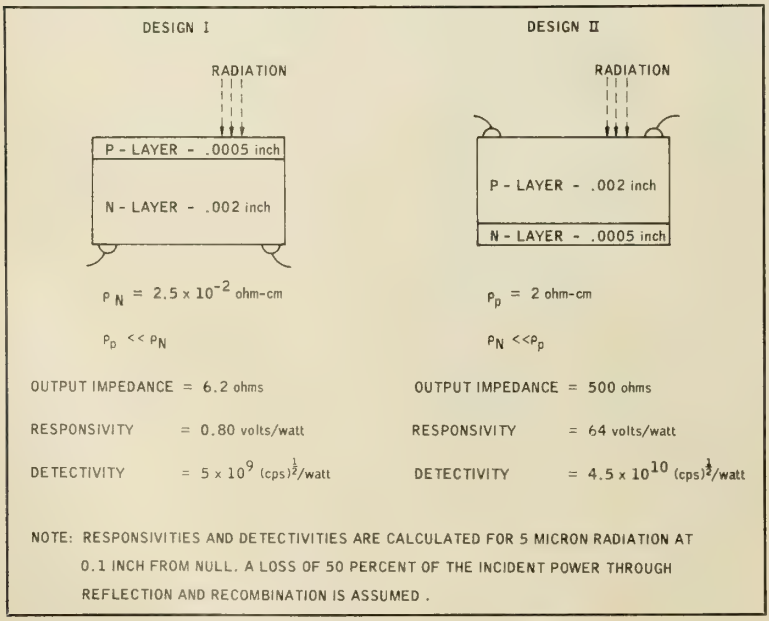
• **Broad usage seen**—EOS engineers stress that the new cells are strictly developmental at the present time. However, considerable enthusiasm for the transducers has developed in both industry and the military because of the varied uses of such devices. Here are just a few already being considered: guidance and control or horizon seekers for satellites or other spacecraft, celestial navigation, missile or aircraft tracking, missile launch orientation, target ranging location of ground light flashes, CRT direct-readout recorder.

The units are believed adaptable as high-speed multiple vector summing devices for computer applications. They could permit fast accurate measurement and inspection of parts and processes for automation control.

The most recent suggestion, and one now being studied seriously by EOS, is the use of the RTT or its IR successor for specialized communications on the ground or in space with a laser system.

A variation of the RTT cell is now being used by Jet Propulsion Laboratory as a photo pickoff for its new miniature accelerometer, only 1.5 cubic inches in total volume. The pickoff for the sensor is 1 by 2 millimeters in area. It uses a narrow field angle, but achieves very high sensitivity.

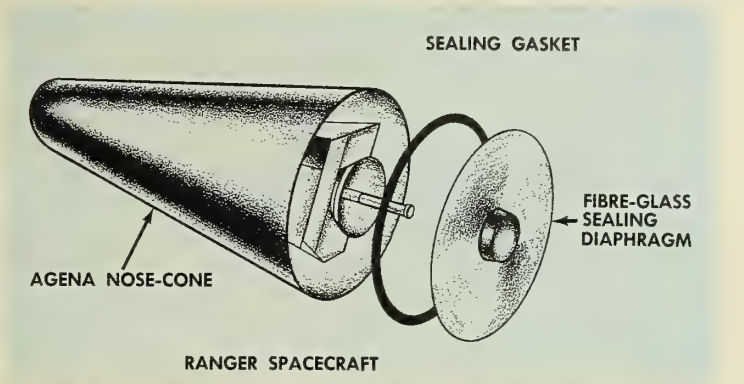
Army uses for the silicon-cell RTT are still classified. ⌘




*DESIGN ALTERNATIVES for the InSb lateral photocell. EOS says the future developmental efforts will be directed toward the second design.*

# How Ranger Payload Is Sterilized

***Lockheed and JPL forced to redesign and compromise to meet added requirement; sterilizing future systems will come easier***




*SEALED COMPARTMENT in Ranger protects payload from all contamination.*

SPACECRAFT designers are facing the painful fact that they must "design in" sterilization now —or pay later for change and compromise.

Lockheed Missiles and Space Division, which worked with Jet Propulsion Laboratory on the first lunar payload, calls sterilization "the grand requirement in exploring celestial bodies."

The command for sterilization came early in the *Ranger* moon-probe program. The National Aeronautics and Space Administration has been increasingly concerned with the fear that "contaminated" spacecraft could wreak a scientific catastrophy by carrying earth microbes to the moon or planets (M/R, Feb. 20, p. 30).

The moon is generally thought to be an airless, barren body with no life of its own. However, there is one theory of the origin of life (though in some disfavor) which could be proven or disproven by investigation of the "moon dust" in its natural state. That is, that spores of living organisms drifted through space and seeded suitable planets. Some of these spores might still be preserved in the nooks and crannies of the moon. Without sterilization this chance could be lost.

Sterilization would not be such a necessity if it were possible to "fence off" the contaminated area around an impact point. Since the moon is almost totally lacking in atmosphere, there will be almost no frictional resistance to particles ejected on hard landing. So even bacteria-sized particles could spread to the far side of the moon, making identification of previously existing conditions impossible.

Unfortunately, design of the *Ranger* vehicle had already begun when the sterilization requirement was laid down. JPL and Lockheed had to design some changes and make some compromises to meet the requirement:

**by Heather M. David**

1) the existing nose cone on the Lockheed *Agena* had to be converted into a sealed-cavity spacecraft compartment, 2) in-flight hardware was developed for aseptic venting and maintenance of biological sterility, 3) a surface sterilization gas-transfer system was designed for ground support.

• **Adaption of nose cone**—A diaphragm or bulkhead of very thin fibreglass was designed to fit between the payload compartment and *Agena* stage of the *Atlas-Agena B*, completely sealing off the nose cone compartment. (Ford Aeronutronic is contractor for the lunar landing capsule.)

After the interior of the enclosed vehicle is sterilized with gases, no part is touched by human hands.

The nose cone eventually will be jettisoned at altitude high enough to prevent atmospheric contamination, but at velocity low enough so that it is left behind.

Since the compartment is airtight, a special pressure relief valve had to be designed into the diaphragm. A Bobrick multiflapper relief valve was chosen, Albin M. Nowitzky wrote in a Lockheed report. The valve provides a gradual adjustment of pressure during ascent, since there are experiments on the spacecraft which cannot sustain sudden pressure change, even if from a very low pressure to zero during the nose cone separation phase.

The valve prohibits inward flow. It is designed so that normal handling inertial loads will not open it, but after the first few minutes of boost it opens by virtue of boost acceleration.

In addition to the valve, a special breathing outlet was installed so pressures will remain stable during temperature changes incurred in filling with sterilization and purging gases.

The breathing outlet is covered with a special biological filter designed by the Millipore Corporation of New Bedford, Mass. Two .45 micron filters separated by ½ inch of fibreglass are used now, but improved Millipore filters are being considered. Flow rate is high since the ratio of pores to solid matrix is 80% to 20%. Each square centimeter of surface contains about 50 million pores, through which no particle larger than 0.80 micron can pass.

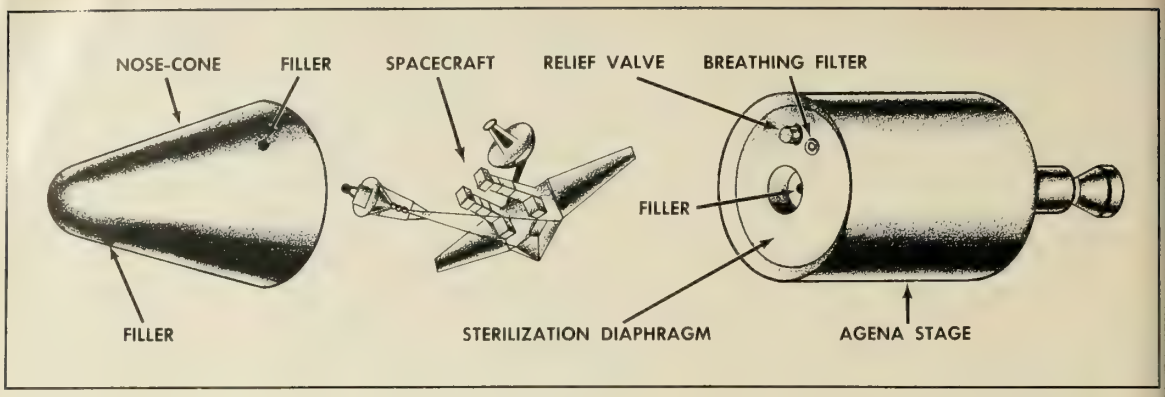
Nowitzky said that huge electrostatic charges are created when air is passed through the filter discs, because of the high dielectric constant, the large electric surface resistivity and the very low capacity for moisture absorption. This electric field gradient provides a high level of collection efficiency, he reported.

The bulkhead also contains a filler valve through which sterilization and purge gases are introduced. A James, Pond, and Clark circle seal check valve is used. In addition, the shroud contains outlet ports near the top to permit expulsion of gases.

• **Component sterilization**—Nowitzky reported that a "new look" had to be taken at vendor component specifications. Some of the problems he listed:

–Guidance and control: what will be the effect of sterilization on lubricants and intricate mechanisms?

–Optics: what about Lyman Alpha telescopic equipment, microscopic de-




*SEPARATION OF RANGER lunar probe will take place at altitude high enough to prevent atmospheric contamination.*

vices and other apparatus requiring control of lens environment and focal length considerations?

–Communications: electron tubes, solid-state transmitters and receivers, capacitors and other electronic equipment will have special problems.

–Life detection sensors: these may require special housings allowing only inflow at moment of sampling, and which would be compatible with outside surface sterilization.

JPL biologist and sterilization expert George Hobby reported to NASA that the group is considering a time-heating schedule for components of 24 hours at about 255°F under dry heat conditions. Materials which are labile to the heat treatment will be irradiated with gamma radiation at dosage levels of $10^7$ roentgens.

As substructures are bolted on to the spacecraft superstructure, each surface will have to be sterilized. If parts are replaced or disassembly takes place, the surfaces will have to be resterilized. Sterilization of contacting surfaces and screwholes during assembly and testing phases is still a problem, Hobby said.

• **Gas sterilization**—A mixture of 12% ethylene oxide inerted with 88% Freon-12 is used to sterilize the entire system. The mixture enters a gas vaporizer from supply bottles in the liquid state, then travels through a humidification group where a water heating and fogging device introduces humidity (25% ±5%).

The sterilization gas passes through a test plenum before entering the payload cavity. Gas pressure, temperature and relative humidity are checked. The breather filter is sealed during the filling operation.

After an 8-14 hour soak period, (the *Ranger* cavity is 164 cu. feet), the sterilization gas is purged with either nitrogen or helium gas. These purge gases, much lighter than ethylene oxide mixture, effect a considerable launch-weight saving. The purge gas is passed through a previously sterilized bacteriological filter assembly, also provided by the Millipore Filter Corp. Purging takes about a half hour, Lockheed said.

As the sterilization gas is pumped from the system, it is combined with water and hydrochloric acid for disposal. Maximum allowable concentration of ethylene oxide in the air is 25-100 parts per million. It is more toxic than chloroform and carbon tetrachloride, but less harmful than hydrogen chloride and sulfur dioxide.

Lockheed advises that personnel exposed to the gases wear chemical safety goggles and have respirators available.

After the purge gas is introduced, the filling apparatus is aseptically removed from the nose cone and the openings are sealed. Until time of boost, inward breathing takes place only through the filtered passage.

George Hobby indicated to NASA that sterilization of future impact systems, such as *Surveyor* and *Prospector*, might be easier. He said the problem could be solved if a spacecraft that could be heated in entirety could be built. Then the whole device could be sterilized under the sealed shroud in a single operation after all assembly and testing had been completed. ⌗

## Three Firms to Study Post-Saturn Vehicles

NORTH AMERICAN Aviation, Georgia Division of Lockheed Aircraft and Convair Division of General Dynamics will make comprehensive, parallel six-month studies of space vehicles beyond the *Saturn* class.

Under contracts awarded by Marshall Space Flight Center, National Aeronautics and Space Administration, the companies will study vehicles with booster thrust of 6 to 12 million lbs.

Comparative cost analyses will be made for each proposed configuration. The most promising will be chosen for further study. Among the configurations studied will be solid-liquid and chemical-nuclear combinations.

Considerations will include the optimum use of nuclear propulsion, desirability of attempted recovery and reuse of large rocket stages, attractiveness of liquid hydrogen and LOX as propellants for a booster stage, and comparisons of the value of solid and liquid propellants, tandem and parallel staging, and pressure-fed and pump-fed systems.

Contract amounts are North American $160,041, Lockheed $136,743 and Convair $130,017.

NASA did not say what areas each company would emphasize. In the past, however, North American spokesmen have favored a nuclear upper stage atop a booster stage based on the conventional liquid-propelled F-1. Lockheed sources have indicated they favor a nuclear stage atop a solid booster. Convair spokesmen have proposed a combined nuclear-chemical rocket that burns LOX and hydrogen and then diverts the hydrogen through a nuclear engine after the relatively small LOX supply runs out. ⌗

## New Propellant Will Raise Scout Capacity One-third

THE ONE-YEAR PROGRAM to uprate the *Scout* third and fourth stages for the *Super Scout* launch vehicle will cost $1.35 million.

The National Aeronautics and Space Administration has completed arrangements for transferring funds to the Navy for the propulsion development, to be carried out at Allegany Ballistics Laboratory, operated for the Navy by Hercules Powder Co.

The major change will be replacement of the current double-base propellant with a more modern formulation, similar to that used in Hercules' upper stages for *Minuteman* and *Polaris A2*. Fiber glass-plastic motor cases will continue to be used, with minor design changes.

The new propellant will increase *Scout's* orbital payload capacity from about 150 lbs. to a little over 200 lbs. ⌗



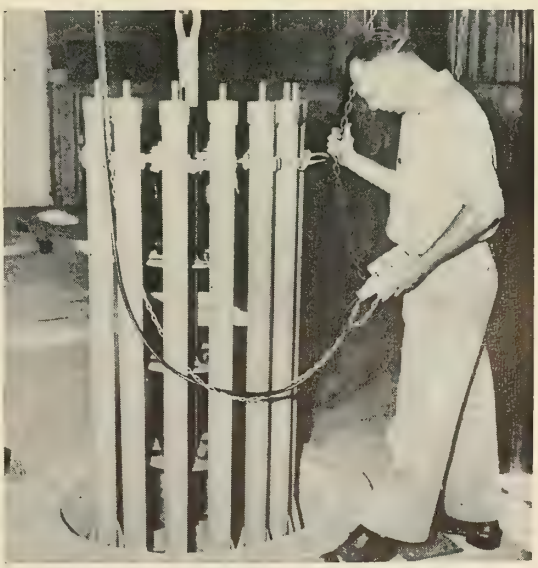

# B.F. Goodrich producing high-energy solid propellants

This static test tunnel is one of the 56 specialized facilities at the B.F. Goodrich solid propellant plant, Rialto, California. BFG-made propellants are currently being processed and loaded in solid fueled rocket motors of the LOKI, RTV and ASP types.

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For complete information on how BFG solid propellant facilities can help you, write for a copy of the new booklet "B.F. Goodrich Solid Propellants for the Space Age". *B.F. Goodrich Aviation Products, a division of The B.F. Goodrich Company, Department MR-3, Akron, Ohio.*



Lowering a rack of small rocket motors into curing pit at the BFG Rialto plant after propellant has been poured into the cases. B.F. Goodrich has been engaged in composite solid propellant research since 1952—in motor production since 1957.

**B.F.Goodrich** aviation products

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# Strength Of Castings Multiplied By Forging

***Armour finds press methods will vastly improve yield and stress; castings may find bigger missile/space role***

**by John F. Judge**

SPECTACULAR INCREASES in the strength of steel castings can be obtained by applying press forging techniques.

Metallurgists at the Armour Research Foundation, Illinois Institute of Technology, Chicago, improved the yield and ultimate tensile stress of AMS 5363A (18-8 stainless) steel by 400-600% and 200-250%.

The investigations may lead to increased use of castings in future missile/space work.

Sponsored by the Air Force's Aeronautical Systems Center, Wright-Patterson AFB, the study also showed that the forging of castings could lead to simplified forgings of complex shapes —particularly with exotic alloys.

Another potential advantage is that the anisotrophy of the forging mechanical properties would be lessened. A part subjected to complex stresses, involving transverse as well as longitudinal loads, could perform better than a forging made from bar stock, which exhibits a directionality of properties before the forging sequence has commenced.

Since the transverse properties decrease as the amount of working increases, the researchers conclude that wrought-forged products in many instances would be inferior to a cast-forged product.

Three different alloys were involved in the program—SAE 4340, AMS 5363A and 17-4 precipitation-hardening stainless steel. Some increases in the physical properties of SAE 4340 were obtained.

The researchers conclude that SAE 4340 composition is not entirely suited to the press forging methods used in the study. The steel's continuous cooling transformation characteristics under stress do not make it amenable to aus-forming-type strengthening in large section sizes.

The improvements with AMS 5363A were obtained by press forging at –100°F with 40% deformation, followed by tempering at 650°F. The 17-4 PH composition increased in both yield and ultimate tensile strengths by about 10%. This was achieved by deforming the predominantly martensitic structure 10% at room temperature then aging at 860°F.

• **Industrial applications**—With respect to the two successful materials Armour sees some difficulties with closed-die forgings at the relatively low temperatures involved. But careful die design, and possibly employment of massive rings around the die periphery could alleviate these problems. Further proper conditions of die design, part configuration and die constraint would make possible a single operation—instead of the three-step approach taken in the study.

Armour says the semi-open die press forging technique is immediately applicable. Selective press forging of highly stressed areas could readily be accomplished upon suitably designed parts.

The fundamental aspects of the project are definitely worth further investigation, says Armour. Three phenomena appear to be responsible for the oustanding property changes in AMS 5363A and 17-4 PH steels.

These are:

–Precipitation prior to martensitic transformation.

–Formation of "martensite of deformation" as opposed to "martensite of cooling."

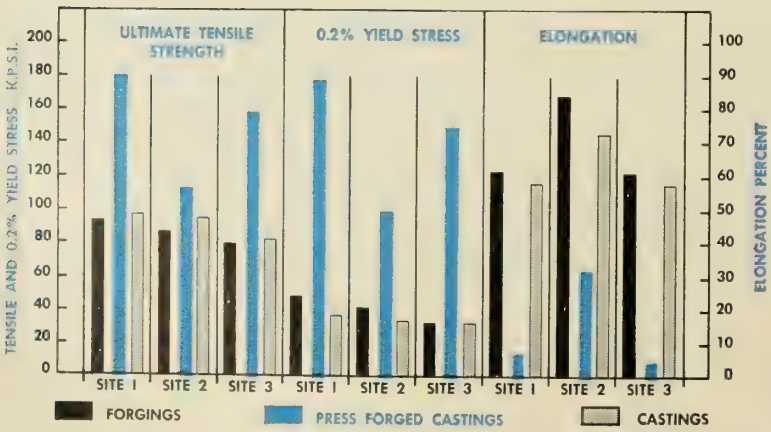
–Effect of deformation of martensite upon subsequent precipitation processes.

Armour recommends that combinations of the processes be included in any future work along these lines.

Most designers have opposed the use of castings in aircraft and missiles usually because of the incidence of internal flaws and variable metallurgical quality found in many commercial castings.

But Armour says the improvement in the mechanical properties and current overall increase in casting quality would render casting more acceptable.

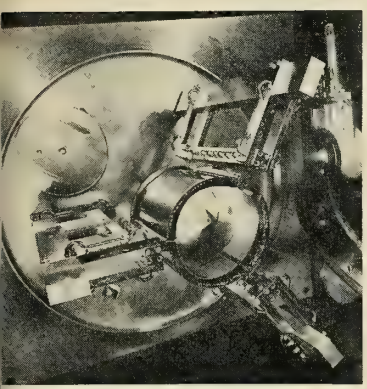
The duplex process has the advantages of imparting higher tensile strengths and increases in yield and proof strength without the ductility increase associated with heat treatment alone. In addition, there is a relative freedom from the marked directional properties encountered in forgings, and a reduction in lead time and cost when compared to forgings for short run or prototype parts.




*COMPARISON OF MECHANICAL PROPERTIES of AMS 5363A stainless steel. Specimens were taken from strut engine parts. Test bars were machined from three different locations within each specimen. Most deformation occurred at the ends of the parts, sites 1 and 3.*

# Hotter Furnace

## EOS Chamber Is Easily Expanded to Double Size



*HEATING AREA of the EOS furnace surrounded by tungsten element, tantalum foil shields.*

A HIGH-TEMPERATURE, high-vacuum furnace developed by Electro-Optical Systems Inc. can be expanded to twice its present size with only minor structural modifications.

The heating area is 7 in. high and 5 in. across. Limited redesign can expand this to at least 12 in. in height and diameter exceeding all known furnaces of its type.

Temperatures of 4700°F in a vacuum of $10^{-6}$ mm Hg are possible. Heating is accomplished by passing a 3000-amp current through a circular tungsten element surrounded by multiple layers of thin tantalum foil which act as heat shields.

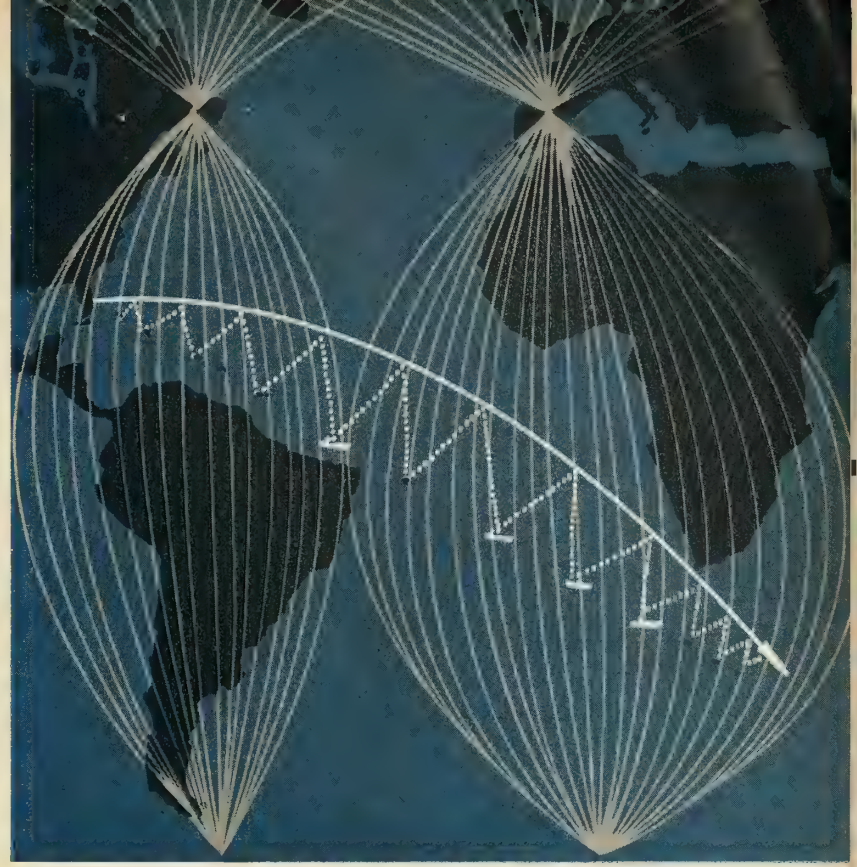
Vacuum apparatus consists of a 146-CFM roughing pump and a 6-in. oil diffusion pump. The furnace can be reduced to $10^{-6}$ mm Hg pressure in about 4 minutes. It has a 30-in.-diameter outer dome of stainless steel, 30 in. high with four 6-in. ports on the side and a 12-in. port on top. This bell can be lifted completely clear of the furnace, providing easy access.

Additional heating area capacity can be obtained by increasing the size of the heat shields and tungsten element within the large outer dome.

The development of the furnace is an offshoot of EOS work on a demonstration ion propulsion motor for the Air Force. The project necessitated the brazing of porous tungsten ionization buttons to a molybdenum surface at high temperatures and vacuum. The uniformity of heating available in the device makes it ideal for high-temperature brazing of refractory metals.

In addition, it can be used for sintering metallic or ceramic compounds or as an environmental testing chamber. ⌗

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# Systems Must be Flight-Tested Soon

***GE's Zipkin says designers can't proceed realistically without further knowledge of effects of environment***

DEVELOPERS of large power systems for manned space missions are reaching the point where they must begin flight tests—or start marking time.

The problem is a lack of data on environmental conditions in space, which still pose major design and developmental difficulties. Designers have gone about as far as they can under simulated space conditions.

The need for flight testing was underlined at a recent meeting of the Institute of Aeronautical Sciences in Cleveland by M. A. Zipkin, manager of the General Electric Co.'s Space Power Operation.

Zipkin covered such considerations as lack of atmosphere, the forces on the system and the pressure of high-velocity meteorites.

Imposed design approaches were illustrated with reference to GE's 500 kw closed cycle, nuclear turbogenerator power supply—a system applicable to Department of Defense-National Aeronautics and Space Administration estimated power requirements for manned lunar exploration missions using the *Saturn* around Fiscal 1968.

Since the system will operate in a hard vacuum, all waste heat must be rejected by radiation. All shaft seals between working fluids and environment must be eliminated, and all materials with high evaporation rates avoided.

The important temperature is the effective sink temperature, said Zipkin. This is caused by radiant heat exchange among the sun, earth and satellite. It is a function of a number of variables including the ratio of absortivity to emissivity of the vehicle surface, the orientation of the vehicle with respect to the heat sources, and the geometry of the system.

Zipkin said the equivalent space sink temperature has very little effect on performance because space power systems have internally generated heat and high radiator temperatures. For example, a radiator operating at 800° F with a sink temperature of 100°F rejects about 5% less heat than it would with a sink temperature of absolute zero.

The anticipated forces on the power system will be negligible and it must be capable of operation under zero "g" condition. This aspect of the environment complicates the boiling and condensing processes and the operating of rotational machinery within the system.

• **Integrated design**—The structural arrangement of the 500 kw system is a cone with the nuclear reactor at the apex behind a shadow which protects the entire system against reactor radiation.

Forward of the shield are the circulating pumps, the heat exchanger, boilers, the turbogenerator with its associated turbine control valves, and the heat exchanger condensers.

A conical shell radiator extends aft of the turbo-machinery area. Two conical sub-cooler radiators are located forward of the main radiator and partially enclosed the turbo-machinery. All components and flow circuits are designed for longitudinal vehicle axis symmetry to minimize moment effects.

The system consists of three major flow loops, each with an associated subloop. Pressurized liquid-metal reactor coolant at 1800°-2000° F is circulated in the primary loop. In the boiler, heat is transferred to the two-phase power loop, which contains the wet vapor turbine, the heat exchanger condenser, and the condensate pump.

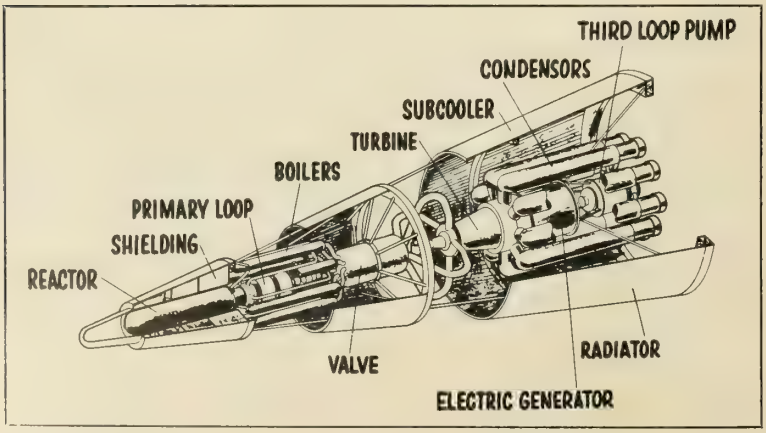
The condenser is cooled by pressurized liquid metal which is circulated by a motor-driven pump through the complex armored tube network of the radiator. Heat is rejected by radiation from the fin surfaces at the rate of about 2.5 kw/ft$^2$ at temperatures around 1200° F.

• **Artificial inertia forces**—In the absence of gravity, the sub-loops must perform the functions of pump inlet pressurization and circulation of motor and generator coolant and bearing lubricant. A centrifugal separator and a jet pump are employed to pressurize the inlet of the power loop condensate pump.

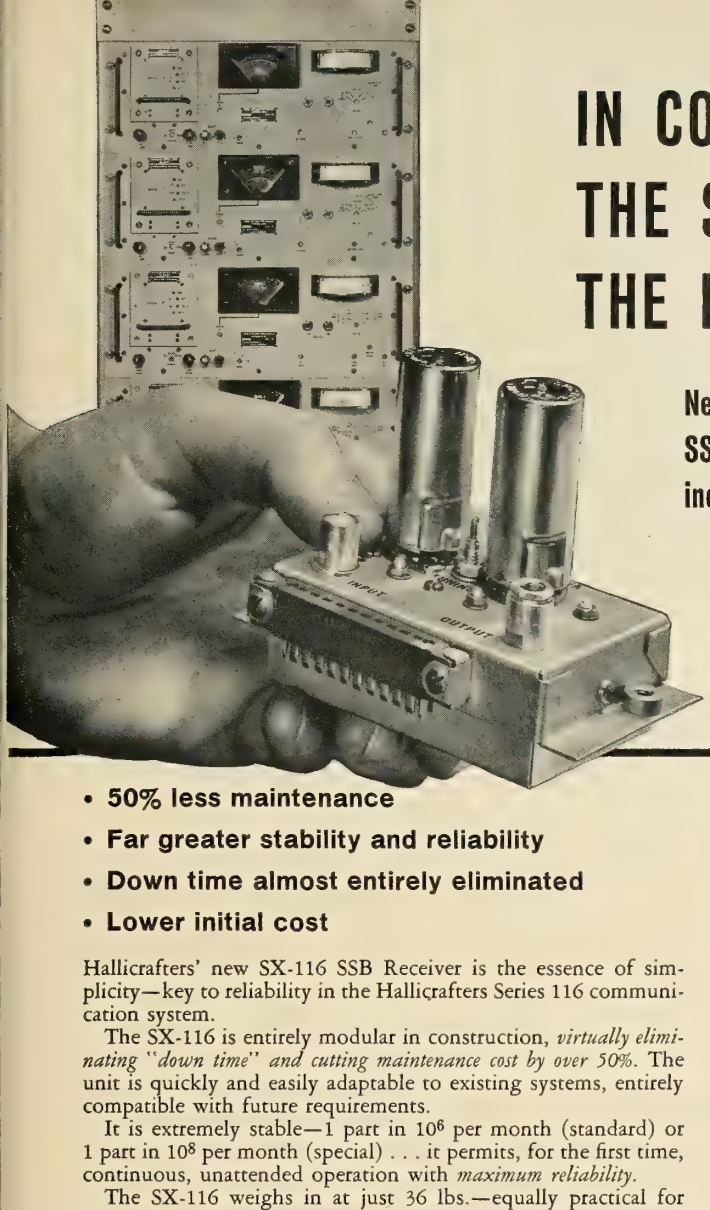
In the reactor and radiator loops, pressurization is achieved with small pumps and whirl chambers. The High temperatures and flow circuit complications are a direct consequence of the component design problems.

Zipkin said space power supplies are vulnerable to meteoroid erosion. Analysis shows that the greatest volume of material is eroded away by meteoroids that have masses below $10^{-7}$ grams. For these tiny objects, the data on impact frequency obtained thus far are too scattered for application to erosion estimates.

Besides the environmental factors, a number of stringent requirements have been imposed on the system. These include the volume and configuration restrictions imposed by the launching vehicle and the necessity for minimum weight without sacrifice of performance or reliability over a specified unattended operating life of at least 10,000 hours.




*GENERAL ELECTRIC's 500 kw closed-cycle, nuclear turbo space power package.*




# IN COMMUNICATIONS... THE SIMPLER THE BETTER

**New Hallicrafters all-modular SSB strip receiver cuts costs, increases reliability.**

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It is extremely stable—1 part in $10^6$ per month (standard) or 1 part in $10^8$ per month (special) . . . it permits, for the first time, continuous, unattended operation with *maximum reliability.*

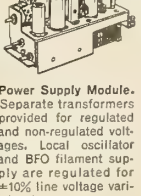
The SX-116 weighs in at just 36 lbs.—equally practical for fixed, mobile, air or seaborne installations. *And its initial cost is very substantially lower.*

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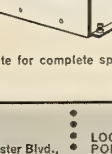
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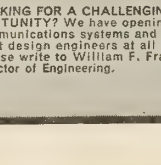
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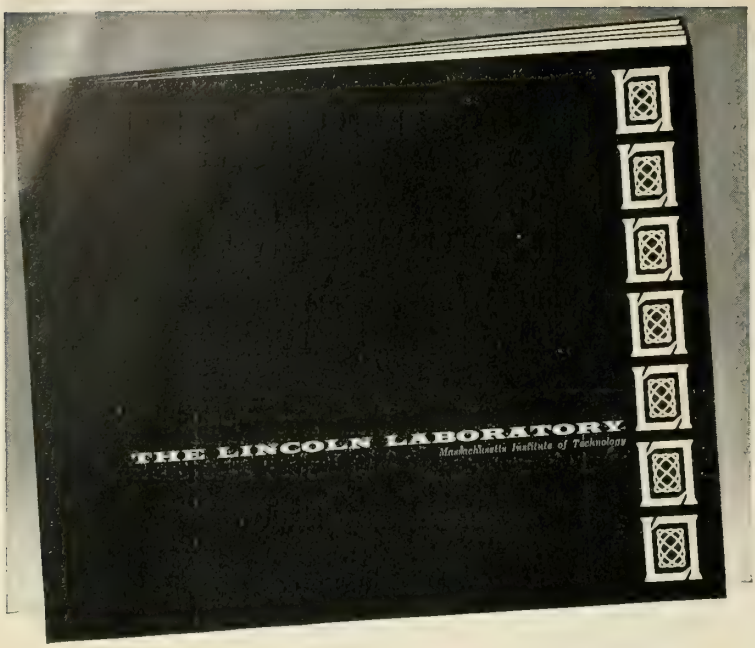
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## Soviets Reported Working On Hybrid Metal Process

A NEW TYPE of metal and alloy processing which simultaneously combines heat treatment, pressure working and magnetization is reported under development at the Moscow Steel Institute.

A magnetic field is applied during austenite-to-martensite transformation, bringing about (1) block fragmentation (by magnetostriction); (2) refining of fine structure as a result of the orientation of martensite crystals parallel to the direction of easy magnetization, and (3) domain arrangement of these crystals.

Thus the magnetic treatment significantly weakens the effect of former austenite grain boundaries on some properties of the steel, such as temper brittleness. In addition, the treatment reduces anisotropy caused by pressure working—since direction of easy slip (110) does not coincide with direction of easy magnetization (100).

Steel 45 (plain carbon steel with 0.42% to 0.50% carbon), water-quenched after being 19% strained at 1550°F in a magnetic field of 2000 gauss, showed a tensile strength of 352,800 psi, with yield strength about 12% lower. Elongation was 6% and reduction in area was 15%. ⌗

## GERSIS to Insure Safety In Nike-Zeus PMR Firing

A MODIFIED VERSION of the *Atlas* radio command-guidance system will be used for range safety instrumentation by Pacific Missile Range when *Atlas* ICBM's are fired to test the *Nike-Zeus* against real target warheads.

The General Electric range safety instrumentation system (GERSIS) will provide the range safety officer with instantaneous precise missile impact prediction to insure the safety of inhabited areas around the impact areas near Kwajalein Atoll.

General Electric has received a $3-million contract for installation and checkout of the system. Electro Steel Structures, Inc. was awarded a $585,000 construction contract for the facility at Pt. Arguello. Construction began Feb. 1.

GERSIS is a high-precision automatic radar tracking system, developed by GE for the *Atlas,* in combination with a Doppler radio system. The data from this combination, when processed by a digital computer, will effectively and instantaneously measure the missile's velocity. The system will then supply complete real-time impact prediction and trajectory data for range safety purposes. ⌗

## Microdot Acquires 4 Space Age Companies

SOUTH PASADENA — Microdot, Inc., has recently concluded a planned expansion-through-acquisition program designed to broaden the product line and telemetry capabilities of its Instrumentation Division. Each of the acquired companies has been a highly successful, specialized manufacturer of electronic products. These companies are:

1) MICRO-TEST, INC., manufacturer of strain measurement devices. Through this addition, Microdot now offers the only high-temperature strain gage in the U. S.—a device capable of continuous measurement at 750° F. and dynamic test to 1500° F.

2) LERCO ELECTRONICS, INC., manufacturer of a wide range of electronic hardware, including molded terminals, terminal boards, handles, Mil-spec knobs, and many others. In all, Lerco catalogs over 380 standard part numbers.

3) NACIMCO PRODUCTS CO., manufacturer of temperature measuring devices and systems. Nacimco is the developer of a special method of producing miniaturized transducer sensing elements through the use of a unique deposited platinum film process.

4) SPECTRALAB INSTRUMENT CO., provides Microdot with outstanding capabilities in the field of VHF and UHF cavities and related instrumentation. This was the first company to give an operational UHF telemetry transmitter and continues to accomplish advanced work in the UHF telemetry field.

According to Microdot President R. E. Dickerman, "At Microdot we keenly feel a dual responsibility; first and foremost to make a positive contribution to the defense of our nation, and secondarily to show a satisfactory growth performance for our shareholders. We believe that we have served both purposes through our recent acquisitions. By strengthening our specialized capabilities, we are achieving a high degree of technological advancement, at utmost speed, with maximum economy."

**MICRODOT INC.**

220 Pasadena Ave.
South Pasadena, California

Circle No. 8 on Subscriber Service Card.

# No man in his right mind would start another war

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## *Production leak testing of big components*

# NOW 4 TIMES FASTER

**It takes just one minute instead of four to evacuate this bell jar and to leak check the large part inside. This high speed is provided by CEC's new 24-120 Leak Detector and 24-025A Test Port Station combination, which leak checks sealed components four times faster than any other mass spectrometer leak detection system.**

**What gives this system such speed? A 2-in. manifold and high capacity vacuum-operated valve in the test port station that permit full use of a 13 cu. ft./min. vacuum pump –*plus* superior vacuum geometry that gives the leak detector fast response.**



**By combining this remarkable test port station and leak detector, smaller components also can be leak checked... at the rate of one part every 8 seconds.**

**The 24-120 instantly locates leaks as small as $5 \times 10^{-11}$ atm./cc./sec. of air ($4.8 \times 10^{-6}$ micron cu. ft./hr.). Used independently, it provides proof of seals in all sizes of equipment, containers, and systems.**

***For more information, write for Bulletin CEC 24120-X8 or call your nearest CEC sales and service office.***

*Analytical & Control Division* CEC

**CONSOLIDATED ELECTRODYNAMICS** / pasadena, california

*A SUBSIDIARY OF* **Bell & Howell** · *FINER PRODUCTS THROUGH IMAGINATION*

## Mercury Hold-up

*(Continued from Page 15)*

cation of the capsule escape system before manned flight. The flight was actually part of the qualification for *Atlas*-boosted orbital flights and much more severe a test than could possibly be imposed by the *Redstone*. Nevertheless, it came at a point in time when success could assure more complete confidence in the system.

The test was largely a repeat of *Little Joe 5* last Nov. 8, in which the escape rockets fired but the capsule failed to separate from the booster as programed. The aim of the test was to fire the escape rockets at an altitude of about 35,000 ft. during powered upward flight, at a time when the forces resulting from speed through the air and atmospheric density exerted a maximum combined load squeezing the capsule back against the booster.

The escape was to be started by a signal that first opens the clamp ring holding the capsule to the booster and then fired the escape rockets. The system is designed to separate the craft from the booster by 150 ft. in 1 second. The parachute landing system then operates a few seconds later.

Analysis of the Nov. 8 flight showed that inadvertent operation of a small limit switch in the clamp ring fired the escape rockets after 15 seconds of flight, before any signal had been given to open the clamp ring. Thus, the capsule and booster remained joined together during the burning of the escape rockets.

On *Little Joe 6*, wiring was changed so that the escape rockets could not fire unless at least two limit switches actuated. The switches are loaded by spring pressure and operate when the pressure of the ring is removed.

Three other changes from *Little Joe 5* were made in *Little Joe 6*. They were:

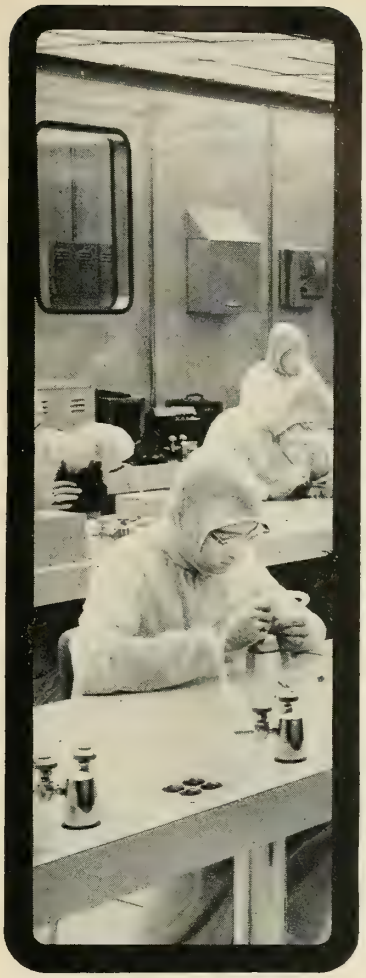
–A large trapezoid-shaped window replaced two small round viewports on the *Little Joe 5* capsule.

–An on-board timer served as the system for starting the abort action after 35 seconds of powered flight. In *Little Joe 5*, after 25 seconds of flight the abort initiation system was to be armed—to fire 10 seconds later. An on-board timing device was to serve merely as a backup. The change simplifies the electrical circuitry.

–The craft will carry a 4-ft. rubberized landing bag, which opens after the parachute is opened at 10,000 ft. to serve as air cushion on landing. The bag will be similar to that carried for the first time on *MR-2*, which broke off when the helicopter made the capsule pickup.

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# "Delivery room" for a guidance system

ıidance systems and components for some of this country's most advanced llistic missiles are being born in this room—and no hospital delivery room as ever kept freer from dust and dirt.

It's the "ultra-clean room" at Sperry Farragut—the cleanest of more than 00 square feet of temperature-controlled clean-room facilities here. Its air cks and dust filters remove from the air all particles larger than 0.3 micron 2 millionths of an inch) and would stop cold the 3-5 micron bacteria dreaded hospitals. Final assembly of guidance units for the MERCURY and SATURN ssiles is carried out here—as well as assembly of a variety of other complex, ecision mechanical and electro-mechanical equipment.

This clean room, probably the most advanced in the country in design and nstruction, is just one example of the ultra-modern facilities for precision ılitary production at Sperry Farragut's 175,000 square-foot Bristol, Tenssee plant. These facilities are manned by a staff with outstanding technical mpetence and backed by the virtually unlimited capabilities of the Sperry nd organization.

Our liaison engineers will welcome an opportunity to discuss application of erry Farragut facilities and capabilities to your requirements. 0.2

*Capabilities and facilities for study, design, evaluation, prototype construction, and final quantity production of precision systems, subsystems, and components for:*

- *Missile guidance and control*
- *Fire control*
- *Aircraft instrumentation*
- *Navigation—land, air and sea*
- *Computers*
- *Trail marking equipment*

SPERRY FARRAGUT COMPANY

DIVISION OF SPERRY RAND CORPORATION
**BRISTOL, TENNESSEE**

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# 'Must' Stop for Missile Salesmen

***Commerce Department's Bureau of Foreign Commerce provides firms seeking to sell abroad with invaluable information—at nominal cost***

**by S. David Pursglove**

SAVVY U.S. MISSILE industry representatives are stopping off in Washington these days before they embark on sales missions to Europe.

They have learned that the U.S. Government spends more than $6 million a year to collect and distribute information which it supplies almost free of charge to American businessmen who sell, or hope to sell, overseas.

The source of this vital data is the Bureau of Foreign Commerce, an agency of the U.S. Department of Commerce, whose assistance is now sought by hundreds of missile and missile-related firms every year.

Sometimes the firms inquire almost casually about market potentials in certain areas—"How many Size 8 servomotors should we be able to sell annually in France, and who buys them?" Other calls come from near-frantic sales representatives—"Where on earth can we get clearance forms to ship seven sounding rockets to England; please explain Line Nine on my sample form; what the devil am I supposed to put on Line 14?"

The Bureau of Foreign Commerce (BFC) does not know how many missile industry firms it aids, because of varying definitions of "missile industry." However, among missile-related industries is the electronics and electrical components business; each week, BFC receives an average of 25 requests for help from this segment alone.

More often, BFC goes to the business community with notices of overseas sales opportunities, tariff changes, new port handling regulations, manufacturing licenses available or wanted.

BFC draws its information from nearly 300 commercial attachés in embassies and business reporters in consulates around the world. The reports are correlated, analyzed and supplemented by BFC "country experts" in Washington. In addition, information is obtained from embassies in Washington, visiting delegations and, finally, by overseas tours of BFC personnel.

Probably more than 90% of businessmen's questions are answered by BFC publications available at the 33 field offices, or through the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. There are three basic guides:

–"How the Bureau of Foreign Commerce Works for You" is a pocket-sized guide to BFC activities—what the Bureau can do for an individual or for his industry as a group, how to contact the BFC, where field offices are.

–"Guide to the Newcomer to World Trade" (15¢) also is helpful to the new man in the overseas division. It defines terms used in export-import affairs, briefly discusses generalized government controls, suggests items to investigate before seeking business and setting prices (e.g., goods may not always be shipped f.o.b. factory, quotations may have to be made f.a.s. United States port or c.i.f. port of destination).

–"Sources of Information on Foreign Trade Practice" (25¢) describes availability of authoritative publications in many areas—market analysis (and analyses available for many commodities and countries), economic statistics, regulations (customs, export-import, exchange, labeling), shipment preparation and transportation, finance, standards, trade terms, arbitration, trade directories, and trade organizations.

One of the missile industry's favorite basic primers on overseas business is "Channels for Trading Abroad" (25¢). Covering briefly the genera business of exporting, this 24-pag pamphlet also touches on several topic of particular interest to the missile related or components firm—compan organizations (built-in department, sep arate export department, internationa company), keys to market analysis methods of selecting local reps.

The most popular BFC publicatio is "Foreign Commerce Weekly" ($6.0 per year). More than 10,000 U.S businessmen subscribe to this compre hensive weekly report on all U.S. an foreign trade regulation changes, in vestment opportunities, sales leads an tips, construction project news, foreig visitor listings, invitations to bid, ma jor loans, licenses available or wanted and interpretive reports on countrie and commodities.

> *E v e n in government-to-government sales of strategic military items, the Commerce Department can aid the companies involved. Clearances and export licenses often are needed even in these cases. "Exporters Service" provides in-person help. Commerce is the businessman's voice in the Government, often can take his case to Pentagon or State Department to aid sale of military-type items in civilian markets overseas; can help businessman ascertain his chances of getting Defense-State okay, helps unblock bureaucratic barriers. Contact Office of Export Supply in Bureau of Foreign Commerce.*

• **Industry appreciation**—What the missile businessman's attitud toward the work of BFC?

–Tyler Nourse, Electronic Indus tries Association: Our industry ha been helped greatly through informa tion supplied by BFC; country desk have been especially helpful. BFC ha helped to ease considerably U.S. expo (licensing) restrictions, especially o tubes and semiconductors. EIA men bers have found BFC's Office of Expo Supply helpful in defining strateg components that need licensing. BF always has served us rapidly with in formation on potential markets an NATO projects open for bids.

–An Aerojet-General official: Mo missile firms have overlooked the hel available from the Commerce Depar ment "probably because they have bee shooting for bigger things—assistanc from the State Department or perha the NATO Standing Group—and don realize that Commerce can greatly ea the day-to-day operations involved doing business overseas."

–Donald Agger, American Nor Aviation, Inc.: I can especially prai "Foreign Commerce Weekly" on i accurate reporting of the NAT Infrastructure developments. This a several-hundred-million-dollar-a-ye program that is rapidly moving fro

he earthwork phase into sophisticated communications, semiautomatic data ransmission and other areas of electronics. The "Weekly" provides rapid and full information for bidding. The Exporters Service office fills a real need n carrying out the bread-and-butter aspects of shipping even strategic materials.

(Exporters Service is a small office, n Room 3836, that helps the businessman determine the clearance needed to ship missile-related materials, supplies forms, and helps in their preparation.)

Other services to the missile industry offered by BFC: Trade lists, World Trade Directory Reports, and services in finding an agent abroad.

Trade lists ($2.00 each, per country) provide names and addresses of firms in a given nation that produce or import specific commodities. Included s company size, products handled, type of operation, sales territory, and a summary of conditions governing trade in he commodity involved.

World Trade Directory Reports $1.00 each) contain information on ndividual foreign firms—names of principals, detailed business operations, preferred language of correspondence, redit report and references, etc. If BFC does not have a new report on he subject firm, or if you need a report n a firm never checked, BFC will run comprehensive check.

Looking for an agent overseas? Give BFC your specifications and a tate Department Foreign Service Offier on the scene will make a detailed nvestigation and report to you on the rospects. Surveys take about 60 days nd cost $10.00 each. Apply for this ervice on Form FC-963, available rom the nearest field office, or request from Commercial Intelligence Div., ureau of Foreign Commerce, U.S. ept. of Commerce, Wash. 25, D.C.

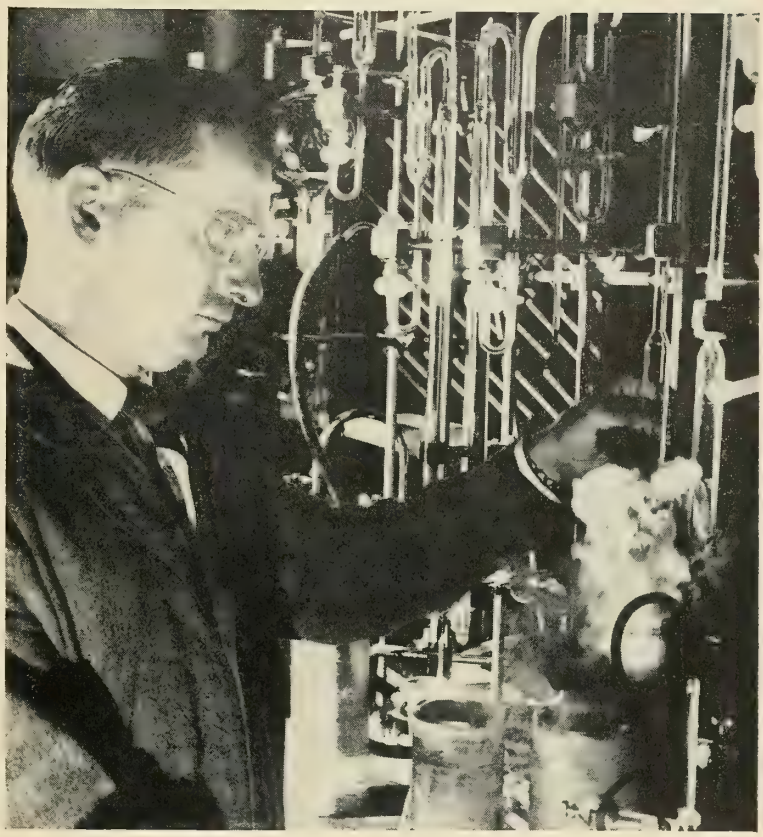
The Bureau is located in the Comerce Department Building, 14th Street etween Constitution Ave. and E treet, N.W. The following men, with eir room numbers and extensions Tel: STerling 3-9200) are country xperts who can help on problems not nswered by the publications (only a w key desks are listed):

United Kingdom—Deane Black, R 065, Ext 2969; France—Robert Sachm, R 3424, Ext 2323; Greece—llen Garland, R 3846, Ext 2429; Italy -Howard Shepston, R 3411, Ext 3500; etherlands—Stephen Conger, R 3427, xt 2919; Belgium-Luxembourg—Robt Walker, R 3427, Ext 2337; Gerany—Karl Koranyi, Ext 2424.

For names of other country experts, for guidance to the appropriate office other problems, contact Miss Faye rbes, Office of Public Information, xt 3681. ❖


# GALLERY

## PROPELLANT BRIEFS



Callery Chemical Company—the originator of boron fuels from test tube to tonnage production—continues to pioneer new avenues of research and development in the high-energy field. Teams of scientists at our Callery, Pa., laboratories are delving into new levels of advanced energy concepts. Objectives: to originate and improve solid and liquid fuels, mono-propellants and solid and liquid oxidizers for use in defense and space exploration missions.

This diversification of effort in the interests of National Defense can be helpful to you. A new laboratory and office in Encino, California, is providing closer liaison with the heart of the missile industry, and brings our capabilities to bear directly where they are most needed.

Callery provides Systems Management as well as subcontract capabilities for research and process development. We are particularly qualified in the fields of propulsion, oxidizers, energy storage, explosive and space manufacturing technologies.

Our sales and research and development personnel are available at all times for technical service regarding the handling, shipping, storage and use of any of our products.

For information or technical service write Defense Products Dept., Callery Chemical Company, Callery, Pa.; or telephone Evans City, Pa., 3510, Ext. 455.

# PRECISE STAR TRACKER



A celestial navigation system called for a tracking device capable of establishing a line of position within an accuracy of 300 feet. Kollmorgen came up with a constant deviation elevation system that positions a movable mirror, in relation to the fixed elements, to a repeatable accuracy of better than 5 parts in a million.

This compact package represents a combination of highly precise optical and electronic units in a housing only 6 x 6 x 10 inches. Kollmorgen's project from concept to installation, it is a typical demonstration of the company's scientific, engineering and manufacturing skills in optics, electronics, mechanics. Example: the precision optics (a prism and two mirrors) are of Kollmorgen manufacture. So, too, are the Inland torque motor*, the gearing and other precision-machined parts.

Our motive in this message: Kollmorgen offers proven capabilities in optics, electronics and precision machining of metal components . . . capabilities which could solve your problems in missile tracking, fire controls, navigation, or . . .?

**Present us with a problem.**

*Product of Inland Motor Corporation of Virginia, a Kollmorgen subsidiary.

Dept. 6-3A

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CORPORATION
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# soviet affairs

By Dr. ALBERT PARRY

### To focus or concentrate electromagnetic waves

over distances may be the aim of Soviet scientists now working on "electromagnetic rock-crushers." If this is the goal, and if the Russians succeed in reaching it, the potential for the Space Age may be tremendous. One of the first significant accounts of these experiments appeared last July 8 in the Moscow *Ekonomicheskaya Gazeta,* and was mentioned briefly in M/R, Oct. 24, 1960. Since that time, there have been two more Soviet press articles on ore-crushing and earth-exploding: in *Krasnaya Zvezda* of Dec. 11 and *Izvestia* of Jan. 19.

### The fact that the chief military newspaper

of the Soviet Union—*Krasnaya Zvezda*—takes up the subject of modern rock-crushing methods is quite interesting. It implies military uses of these "rock-crushing sparks," as well as peaceful industrial purposes. The *Krasnaya Zvezda* article describes experiments in which wires running through water are employed. It quotes L. A. Yutkin, a scientist connected with the Leningrad Polytechnic Institute who is in charge of this work, that "miniature lightnings cause a super-high pressure as they travel through the liquid and bring about a shock wave of destructive force." Instead of "electromagnetic" he uses the word "electrohydraulic."

### Extra-hard sulfide-quartz ores

of the Zyrianovsky Mine in East Kazakhstan (Russian Central Asia) were selected for some of the experiments discussed in this report in the main organ of the Soviet ministry of defense. The two engineers heading this work, A. Safronov and Yu. Kiselev, declare that results so far have been eminently positive. *Krasnaya Zvezda,* calling this method "the technology of tomorrow," cites Safronov's prediction: "Plants will get rid of hundreds of expensive mechanisms; thousands of workers will be freed for other tasks; productivity of labor will increase more than tenfold." Among other future developments, ships at sea will be moved by engines built "on such a principle . . . of electrohydraulic effect."

### Neither electromagnetic nor electrohydraulic methods

are mentioned in the *Izvestia* article of Jan. 19. This account stresses the necessity of throwing the exploded rocks or masses of earth to specific places, well defined in advance. It praises Professor George I. Pokrovsky for his achievements in such precise "targeting," saying that he "has made a prominent contribution to this cause" of "guided transfers of masses of earth" in explosions. The *Izvestia* article is entitled "Peaceful Explosions," but a well-informed reader will recall that Professor Pokrovsky is not only a doctor of the technical sciences, but also a major general in the engineering branch of the Soviet armed forces and a faculty member of the world-renowned Zhukovsky Military Air Academy in Moscow. Author of *Guided Effect of Explosion* and other standard books on the subject, Professor Pokrovsky is one of Russia's outstanding experts on long-range ballistic missiles. He was first introduction to the world at large in August and September, 1957, when he served as a foremost official commentator on Mascow's initial announcement of achieving a workable ICBM.

### None of these recent Russian articles

makes it clear whether the rock-crushing electrodes—be they magnetic, hydraulic, or of whatever other variety—are buried in, or in contact with, the rock they crush and the earth they explode and throw to its predestined sites. Such conductors may well be so buried or in such contact. However, they may already be operating at a distance, or, at least, Soviet scientists may be trying to make them work at a distance. If operation at a distance is indeed involved, the importance of these Russian experiments in the Missile/Space Age cannot be underrated.

## ARS, ASME Meet Concurrently in LA

LOS ANGELES—Size and reliability were keynoted at two technical meetings held here in the past week.

Huge vehicles contrasted with microminiature electronics, patterns of failure in components, and numerous other missile/space subjects were covered by the American Rocket Society and the American Society of Mechanical Engineers during three-day conferences held a few blocks apart.

Impatience with the current pace of space programs prompted several ARS speakers to call unofficially for replacing incremental progress with bold reaches.

R. C. Truax, of Aerojet-General Corp., pointed out that the German *V-2* was scaled up 336 times from its immediate predecessor in a near-successful bid to win World War II.

Truax, and J. D. Ryan presented a paper advocating large boosters launched at sea and recovered after use. They said feasibility could be proved by using *Aerobee* rockets.

Instantaneous course changes for space vehicles commanded from the ground was held out as a possibility by Robert E. Carlson, of Pacific Missile Range, who spoke on a real-time computer capable of providing in-flight data on a missile or space vehicle in a tenth of a second.

In the solid-propellant rocket field, Rudolph A. Peterson of Aerojet told the ARS that large-scale production of continuously mixed castable composite propellants might answer future demand for many high-thrust solid rockets.

A simplified method of picking up floating data capsules was described by Royal C. Schendel and Frank J. Brennan of the Navy Missile and Astronautics Center, whose proposal involved use of inflatable loops that would be snagged by a pickup hook from a plane.

In instrumentation, a paper presented by Alexander M. Voutsas of American Bosch Arma Corp. detailed a digital angle readout device capable of three-tenths second arc accuracy. It uses resonant frequency of a twisted beam or wire, varied with twist angle, to directly measure angular deviation.

In materials research, Ford Motor Co.'s Aeronutronic Division described its Ausform process of thermomechanically treating alloy steels to attain ultrahigh strength levels. Strength-to-weight ratios of 1,000,000 in.-lb. per lb. are expected after perfection of the treatment, which is specifically tailored to production of rockets. The process mainly consists of deforming metals plastically while in the metastable austenitic condition.


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**"DETASHEET"* FLEXIBLE EXPLOSIVE:**

**you can tailor it to suit the job**

**You can bend and cut** Du Pont "Detasheet" flexible explosive like plastic sheeting, snug it right up against the surfaces to be cut, shaped, formed or destroyed.

Apply it in sheets, patches, coils, cylinders . . . any configuration you need, and in the exact amount required, thereby conserving space and weight in the system you are designing.

It also comes in perforated, triangular form for use as a line-wave generator for precision timing and other specialized applications. In this case the detonation initiated at any apex will proceed as a straight-line detonation zone to the opposite edge.

**Du Pont "Detasheet"** gives you design freedom unavailable with conventional explosives. Suggested uses include: destruct systems for classified components, separations, diaphragm rupture, destruction of spent propellant cases, perforation of rocket cases to change direction or velocity, etc.

For details on "Detasheet", contact your Du Pont Explosive Systems Specialist, by writing Du Pont, 2446 Nemours Building, Wilmington 98, Delaware.

* Trademark of E. I. du Pont de Nemours & Co., Inc., for its flexible sheet explosive.

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## NASA

$2,000,000—**Astronautics Division of Chance Vought Corp.**, Dallas, for fuel and liquid oxygen tanks for the *Saturn* booster program.

$1,052,434—**Redstone Arsenal**, Huntsville, Ala., for services and supplies including fire protection, technical library services, pictorial services, vibration testing of *Saturn* components, rocket motors for use in the *Juno II* program, and establishment of vibration test program in connection with space vehicles.

$865,000—**Air Research and Development Command**, Andrews AFB, Washington, D.C., for additional studies and preliminary design of the S-V stage for the *Saturn C-1* vehicle by **Convair Astronautics**, and propellants for a 17,500-lb.-thrust engine.

$362,642—**Chrysler Corp.**, Detroit, for investigation of corrosion and corrosion prevention in the *Saturn* vehicle and to assure proper operation and highest possible reliability of tactical ground support equipment used in firings of the tactical *Jupiter* weapons system at Cape Canaveral.

$335,000—**Georgia Division of Lockheed Aircraft Corp.**, Marietta, for pressure and functional checkout equipment for the *Saturn* booster.

$321,201—**Hughes Aircraft Co.**, Malibu, Calif., for applied research, development, fabrication and experimental testing of an ion rocket engine.




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7,000 GAL. $LH_2$ DEWAR BY STEARNS-ROGER FOR MISSILE COMPONENT TEST.



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$308,528—**North American Aviation, In** Downey, Calif., for conceptual desig studies of space vehicles.

$226,796—**The Martin Company**, Baltimor for heat exchanger coil assemblies a conceptual design studies of a spa vehicle.

$130,017—**Convair Division of General D namics Corp.**, San Diego, Calif.; $136,7 —**Lockheed Aircraft Georgia Division** Marietta; $160,041—**North American Av ation, Inc.**, Los Angeles; for comprehensi studies of possible future space vehicl beyond the *Saturn* class, rockets havi first-stage thrust of six to twelve millio pounds.

$120,000—**Arnold Engineering Developme Center, Air Research and Developme Command, Tullahoma, Tenn.**, for spac vehicle wind-tunnel testing.

$119,160—**Electro Optical Systems**, Pasaden Calif., for ionizer development, surfa physics studies, and a study to determi flight test objectives for ion propulsio systems.

$59,945—**The Marquardt Corp.**, Van Nuy Calif., for investigation of exhaust-nozz flow phenomena in arc-jet engines.

$50,000—**Stanford University**, Stanford, Cali for study of systems for space propulsio

$44,411—**Plasmadyne Corp.**, Santa Ana, Cali for study of flight-test objectives f electro-thermal propulsion systems.

$41,000—**The Wallingford Steel Co.**, Walling ford, Conn., for special alloys for Lew Research Center, Cleveland, Ohio.

**The Astronautics Division of Chance Vough Corporation**, Dallas, for study of wa of assembling and launching space ve hicles from an earth orbit. No amou disclosed.

**Radio Corporation of America, West Coa Missile and Surface Radar Division**, Va Nuys, Calif., for the *Saturn* ground com puter system. No amount disclosed.

## NAVY

$14,000,000—**The Martin Company**, Baltimor for production of *Bullpup* missiles.

$7,300,000—**Westinghouse Electric Corp.**, Ba timore, for development and productio of the weapon direction equipment po tion of the *Typhon* weapon system.

$141,000—**Planning Research Corp.**, Los An geles, from **Lockheed Missile and Spac Division**, for one-year advanced stud program on the *Polaris* missile.

$50,000—**Atlantic Research Corp.**, Alexandri Va., research to further develop th *ARCAS* rocketsonde system.

## ARMY

$1,328,000—**AiResearch Manufacturing Co** Phoenix, Ariz., letter contract for ga turbine generator sets for the *Sergeant* missile system.

**Dumont Manufacturing Corporation**, Sa Rafael, Calif., for all-plastic nozzles fo the first and second-stage rocket moto of the *Pershing* missile. Subcontrac from **Thiokol Chemical Corp.-Redstor Division**. No amount disclosed.

## AIR FORCE

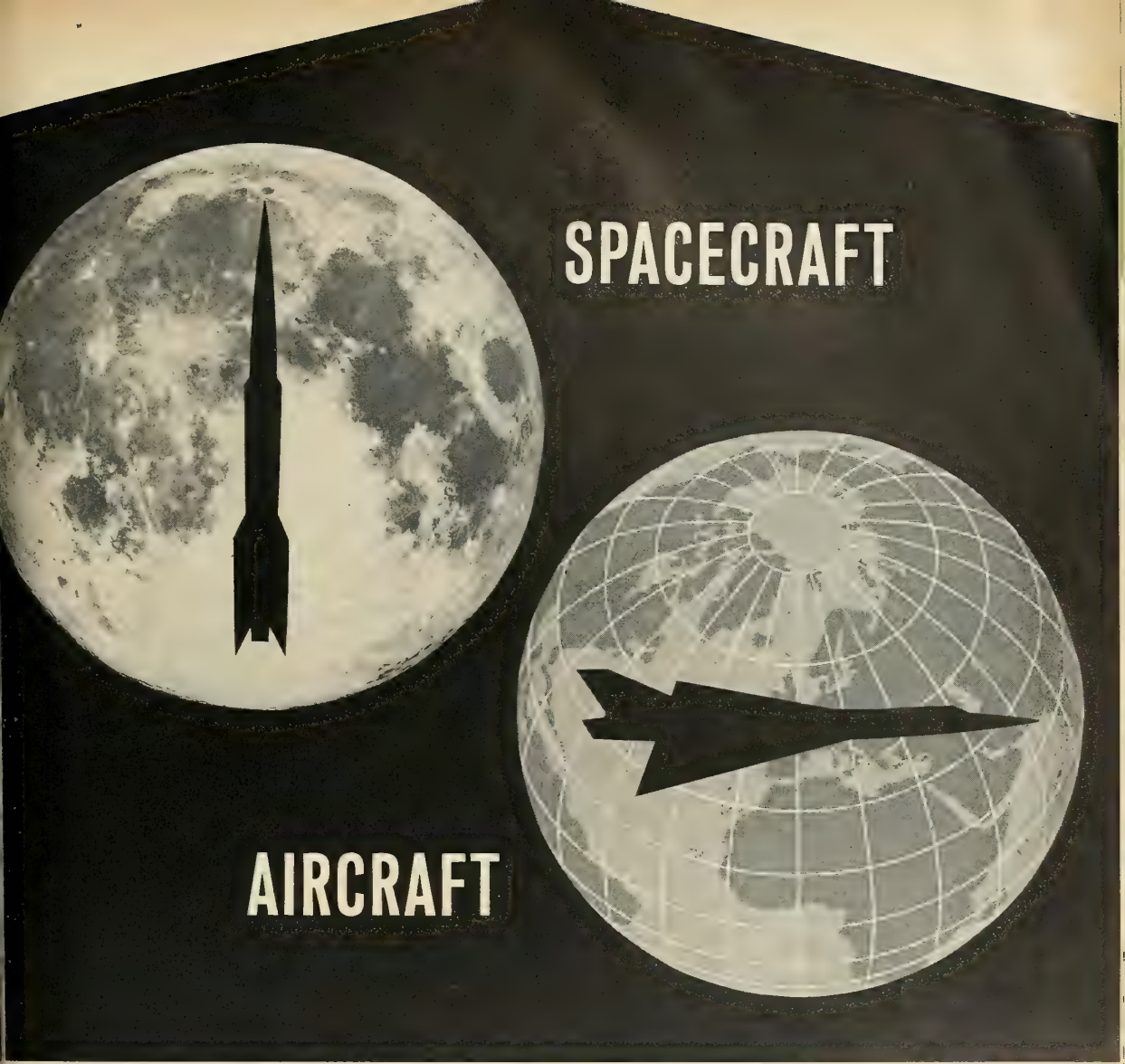
$28,000,000—**General Electric Company's Mi sile and Space Vehicle Department**, fo development of the re-entry vehicle fo the advanced *Titan II* ICBM.

$300,000—**United Control Corp.**, Seattle, fo liquid-oxygen level indicating equipmen for the fuel system of the *Titan* ICBM Subcontract from **The Martin Co.**

$246,195—**Dynatronics, Inc.**, Orlando, Fla for a telemetry predetection recorde receiver and reproducer system for mis sile test requirements at AMR.

$200,000—**Microdot, Inc.**, South Pasadena Calif., for precision temperature measur ing systems for the advanced version o the *Titan* missile. Subcontract from **Th Martin Company.**

$122,750—**Vitro Electronics, Division of Vitr Corp. of America**, Silver Spring, Md., fo five airborne telemetry receiving system for the Missile Test Center at Patric AFB, Fla.




## NOW UNDER ONE ROOF AT LOCKHEED / BURBANK

Lockheed California Division has expanded its already great resources at Burbank. For it now encompasses, under one roof, the two vast worlds of Spacecraft and Aircraft.

This typifies Lockheed policy to steadily advance the state of the art through basic research in related and scientific fields.

Result? Now—more than ever—Lockheed offers Scientists and Engineers uncommon opportunities; equips them with every modern facility; gives them freedom to explore and express new ideas; makes possible greater individual recognition.

Now being designed and developed in Spacecraft and Aircraft are: Hypersonic interceptors; V/STOL; supersonic interceptors; limocopters; missiles; manned spacecraft; and satellites.

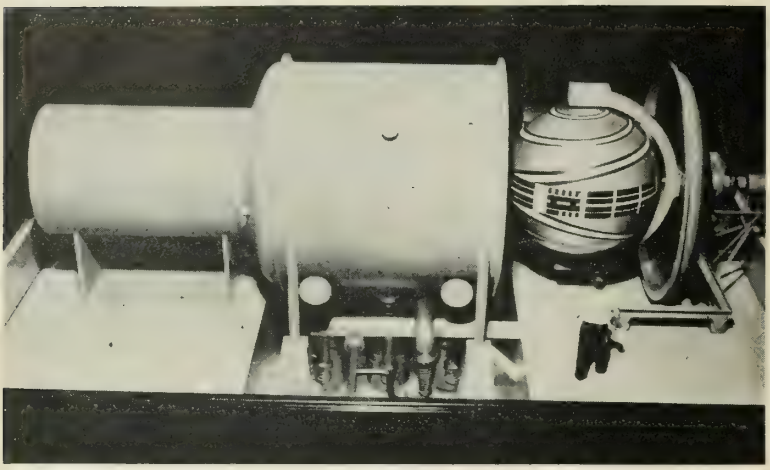
**Scientists and Engineers of outstanding talent** are now invited to participate in this new, dual enterprise. Immediate openings are available to: Aerodynamics engineers; thermodynamics engineers; dynamicists; electronic research engineers; servosystem engineers; electronic systems engineers; biophysicists; infrared physicists; hydrodynamicists; ocean systems scientists; physio-psychological research specialists; mammalian culture research specialists; and radiation hazards specialists.

Write today to Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1703, 2404 N. Hollywood Way, Burbank, California.

**LOCKHEED**

CALIFORNIA DIVISION

*Featuring "New Idea" electronic products introduced this week at the 1961 Institute of Radio Engineers' International Convention in New York City.*



## Satellite Orbital Simulator

An advanced orbital simulator, capable of testing an eight-foot satellite spinning in two directions, has been developed by the Aerospace division of Tenney Engineering, Inc.

The simulator will provide space thermal radiation levels and solar spectral radiation of variable flux, earth to Mars, as well as a special heat sink "black wall," refrigerated to –320°F with liquid nitrogen to absorb radiation and prevent bounce-back to the test object—exactly as in space.

The chamber, a stainless steel cylinder, will be 12 feet in diameter and 11 feet long. Pressure will be reduced to $1 \times 10^{-7}$ mm Hg, or 1,100,000 feet. The cryogenic system will dissipate a maximum heat load of 700,000 BTU/hr.

Circle No. 225 on Subscriber Service Card.

## Subminiature Tubes

Four high-gain, low-noise, subminiature receiving tubes utilizing a strap-frame grid construction are available from Sylvania Electric Products Inc.

Sylvania will display two medium mu UHF double triodes and two high mu UHF triodes. Features of the medium mu triodes, compared with their prototypes, are: one exhibits a 100% increase in Gm and Gm per milliampere of $I_b$, the other has 80% higher Gm at 40% lower plate voltage and 20% lower heater power. Features of the high mu triodes are: one has a 1300/1 ratio of Gm to $I_b$, while the other employs one-third the heater power with a 3db improvement in noise figure.

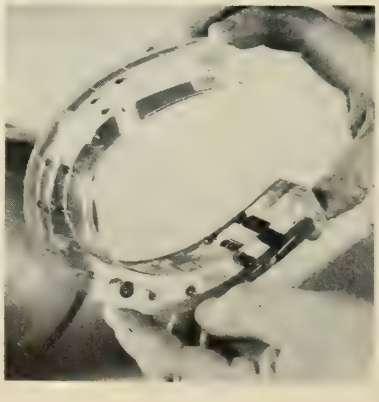
Circle No. 226 on Subscriber Service Card.

## Flexible Silicone Resin

A silicone encapsulating material that permits visual inspection of circuits and components within potted, embedded or encapsulated assemblies will be introduced by Dow Corning Corp.

Applied as an almost colorless liquid —after blending with its curing agent— Sylgard 182 cures in place even in totally confined enclosures, to form a transparent mass having outstanding dielectric properties, good moisture resistance and the physical attributes of flexibility and toughness.

Circle No. 227 on Subscriber Service Card.



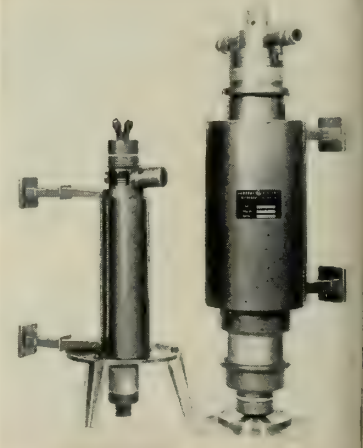
## Battery Systems

Three battery systems are being developed by Yardney Electric Corp. One is a sea-water battery; another is a sealed form of rechargeable silver-cadmium battery; the third is a new automatically activated primary battery system having a minimum of parts and offering maximum flexibility in packaging.

Circle No. 228 on Subscriber Service Card.

## Traveling Wave Tubes

Two compact metal-ceramic traveling wave tubes designed to operate as the driver and final amplifier in a pulsed high-power chain are now available from General Electric Corp. for X-band radar applications.



Type Z-3090, the driver tube covers the 8500-to-9600 megacycle frequency range and has a peak power output of 10 kilowatts. Power gain is 35 db, efficiency 15%, and maximum duty cycle 0.005. The tube also can be used as a final amplifier in a medium power application.

The amplifier tube, type Z-3091, covers the 8600-to-9600 megacycle range and has a peak power output of 500 kilowatts. Power gain is 20 db, efficiency 25%, and nominal duty cycle 0.004.

Circle No. 229 on Subscriber Service Card.

## Readout Photocells

A series of silicon readout photocells providing very fast response time (from 5 to 20 microseconds), capable of reading 10,000 characters per second

in perforated tape and punched card data reading systems, is available from International Rectifier Corp. The cell series is available with 5, 6, 8, 9 or 10 readout positions, with an active cell area (per segment) of 0.128 x 0.067 in., and center-to-center spacing of 0.087 in.

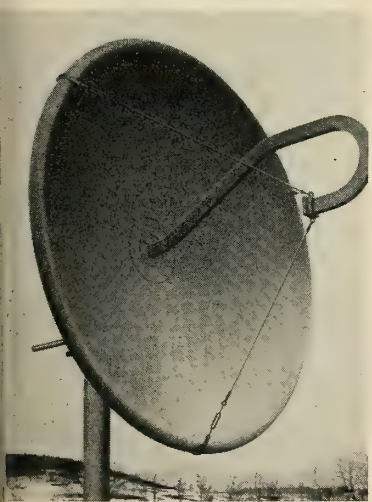
All units provide extremely high sensitivity, operation to 150°C, and very low noise output. Typical current generated is 350 microamperes for 0.01 sq. in. of active cell area at 1000 foot-candles illumination.

Circle No. 230 on Subscriber Service Card.

## Microwave Antenna

Technical Appliance Corp. have available microwave antennas and a rigid coaxial transmission line.

The Antenna line includes frequency ranges from 806 MC to 12.7 KMC. Reflector sizes range from 2 to 12 feet, depending on frequency range. A highlight of the line is 12-ft. mesh reflectors available in the 900 mc and 2000 mc frequency bands.



The transmission line is offered with choice of copper or aluminum outer onductor. Standard EIA flanges or ACO "Quick Clamps" may be rovided.

Circle No. 231 on Subscriber Service Card.

## Microcomponent Pellet Assembly

A microminiaturization technique hich shrinks circuit elements to pellets /10 in. in diameter and 1/16 in. high ill be demonstrated by P. R. Mallory Co. Inc. Mallory engineers will use ellet resistors, capacitors and diodes n combination with conventional micro-iniature transistors to fabricate binary ividers in the form of microcircuit gic blocks.

The microcomponents fit into holes


CIRCLE SEAL precision valves

# PRECISION VALVES

*...the valve that is guaranteed not to leak!*

Design and application experience gained in developing and manufacturing truly leakproof valves has enabled Circle Seal to earn and retain its position of leadership. Advanced design concepts based upon extensive experience and investigation make Circle Seal valves the ultimate in quality and reliability. These time-proven concepts, incorporated in the valves below are designed to help you select the *right* valve for your specific application.

## CIRCLE SEAL VALVES FOR AIRCRAFT, MISSILE AND GROUND SUPPORT REQUIREMENTS

| | Aircraft | | | | | | | | Missiles & Rockets | | | | | | | Ground Support | | | | | TYPICAL VALVE TYPES | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fuel | Pneumatics | Hydraulics | Purge & Inerting | Oxygen | Water & Alcohol | Lubricating Oil | Fuel | Oxidizer | Pneumatic Control | Hydraulic Control | Cryogenics | Electronics | Packaging | Control Panels | Inerting System | Hydraulic Control | Pneumatic Control | Fuel Handling | STANDARD | SPECIAL |
| Automatic Drain | ● | | | ● | | | | | ● | | | | | | | | | | | | P7-526, P19-526 |
| Bleed, Manual | | ● | ● | ● | ● | | | | | ● | | | | ● | | | | ● | | | P12-228, P4-416 |
| Check, Low Pressure | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | 800 | P6-620, P3-319 |
| Check, High Pressure | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● | | | ● | ● | ● | ● | ● | | 200/2100/2600 | |
| Check, Restricter | ● | ● | ● | | | | ● | ● | ● | ● | ● | | | ● | | ● | ● | | | | P 649, P9 649 |
| Check, Modular | ● | ● | ● | | ● | ● | ● | ● | ● | ● | ● | ● | | | | ● | ● | | | | P1 278, P5 356 |
| Check, Vent Port | ● | ● | ● | | | | | ● | ● | ● | ● | | | ● | ● | ● | ● | ● | | | P4-673, P 698 |
| Check—Relief | ● | | ● | | | | ● | ● | ● | | ● | | | | | | | | | | P 389 types |
| Checkout, System | | | | | | | | ● | ● | ● | ● | | | | | ● | ● | ● | | | P1-425, P2-425 |
| Drain, Automatic | ● | | | ● | | ● | | ● | ● | | ● | | | | ● | | | ● | | | P7 526, P19-526 |
| Drain, Manual | | ● | ● | | | | ● | | | ● | | | | | | | | ● | | 9200 | P-394, P-427 |
| Filler | | ● | ● | | | | | | | ● | | | | | | | | ● | | | P4-308, P4-691 |
| Fill & Bleed | | | ● | ● | | | | | | ● | ● | | | ● | | | | | | | P20 228, P1-427 |
| Gauge Protector | | | | | | | | | | | | | | | ● | | | | | 1100 | |
| Relief, Low Pressure | | ● | ● | ● | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | | | ● | 500 | P12-352, P4-637 |
| Relief, High Press. | ● | | | | | | | ● | ● | | ● | | | | ● | | ● | | ● | 5100 | |
| Relief, Modular | | | ● | | | | ● | ● | ● | | ● | ● | | | | | ● | | ● | | P4 648, P7 349 |
| Relief, Thermal | ● | | ● | ● | | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | ● | | ● | | P12-352, P27-220 |
| Relief, Vacuum | ● | | ● | ● | | | ● | ● | ● | | ● | ● | ● | | ● | | | | ● | | P 262, P2 534 |
| Selector, Manual | | | | | | ● | ● | | | | | | | | ● | | | | | | P7 418, P48 395 |
| Shut-off, Manual, H.P. | | ● | ● | ● | ● | | ● | | | ● | ● | | | | ● | ● | ● | ● | | 900 | P15-350, P6-406 |
| Shut-off, Manual, L.P. | | ● | ● | ● | ● | ● | ● | | | ● | ● | | ● | | ● | ● | ● | ● | | 9200 | P3-395, P45-395 |
| Shut-off, Vacuum | | ● | | ● | | | | | | ● | | | ● | | ● | ● | | ● | | 9200 | P3 395, P45 395 |
| Shuttle | ● | ● | | | ● | | | ● | ● | ● | ● | ● | | | ● | | ● | ● | ● | 400 | P 652, P 702 |
| Vacuum Breaker | ● | | ● | ● | | | ● | ● | ● | | ● | | ● | | | ● | | | ● | | P-262, P2-534 |
| Vent & Breather | ● | | ● | ● | | | ● | | | ● | | ● | ● | | | ● | ● | | ● | | P-249/P 262, P5-308 |
| Vent, Float Actuated | ● | | | | | | | | | | | | | | | | | | | | P 401, P5-401 |

Typical standard lines of off-the-shelf type valves based upon proven Circle Seal design concepts are shown below:

**200 SERIES CHECK VALVE**



**The one perfect answer for virtually any check valve requirement.**
- Zero leakage, 0-3000 psi
- Low cracking pressure
- Adaptable to most fluids
- Unequalled reliability

Technical Data Form #3S-2044R

**2100 SERIES CHECK VALVE**



**Advanced check valve design utilizing the proven Circle Seal Principles in high pressure pneumatic systems.**
- Zero leakage, 0-3000 psi
- Exceptional durability
- Designed to withstand surge flows
- Compact, light-weight

Technical Data Form #3S 2283

**2600 SERIES CHECK VALVE**



**Precision check valve performance in minimum package size.**
- Versatile pressure range, 0-3000 psi
- Minimum size and weight
- Suitable for any mounting position
- Maintenance free reliability

Technical Data Form #3S 2284

**800 SERIES CHECK VALVE**



**The one perfect answer for applications requiring a combination of low pressure drop and zero leakage.**
- Zero leakage, 0-600 psi
- Low cracking pressure, low pressure drop
- Suitable for any mounting position
- Not affected by "O" Ring swell

Technical Data Form #3S 2046R

**400 SERIES SHUTTLE VALVE**



**The ultimate in automatic circuit switchover for low pressure and high pressure liquid and gas systems.**
- Minimum interflow
- Very low shuttling pressure
- No cross-port leakage
- Absolute reliability -- accurate shuttle response

Technical Data Form #3S-2242

**500 SERIES RELIEF VALVE**



**A precise reliable combination of small size and full flow capacity.**
- Zero leakage virtually to cracking pressure
- Reseat dead tight, close to cracking pressure
- Opens freely without sticking
- Maximum flow—minimum size

Technical Data Form #3S-2145R

**5100 SERIES RELIEF VALVE**



**Combines the simplicity of direct actuation with accurate reliable performance in virtually any gas or liquid service.**
- Adjustability for precise setting
- Zero leakage at normal system pressures
- Smooth, chatter-free operation
- Minimum hysteresis

Technical Data Form #3S-2118R

**900 SERIES SHUT-OFF VALVE**



**The one perfect answer for system shutoff where leakage cannot be tolerated.**
- Zero leakage, 0-6000 psi with gas or liquid
- Metered opening to protect system
- Low operating torque
- Maintenance-free operation

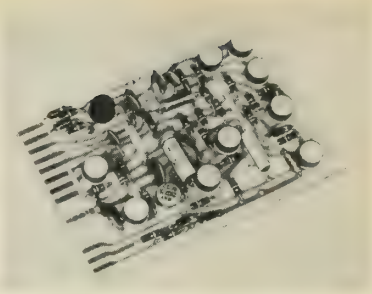
Technical Data Form #3S-2238

CIRCLE SEAL precision valves

JAMES, POND & CLARK, INC.
2181 East Foothill Boulevard
Pasadena, California

in component boards, along with terminals which are pressed into slots along the edges of the boards. A printed circuit pattern on each board is connected with pellets by conductive cement; the boards are then cast into transparent epoxy blocks measuring 1 in. x .85 in. x .14 in. Completed units are then plugged into a binary adder for testing.

Circle No. 232 on Subscriber Service Card.



## Operational Amplifier

An operational amplifier specifically designed for exceptionally reliable operation is now available from Donner Scientific Co.

The solid-state amplifier, Model 3801, uses silicon transistors throughout to provide both the high-gain, wide-bandwidth path and the chopper-stabilization path. In standard form, the Model 3801 will operate over a temperature range from 0°C to +55°C in a relative humidity of 95%. It will withstand shock of 30 g and meet all specifications to an altitude of 50,000 feet.

*ERRATUM: The above is the corrected version of a product release which appeared in the Feb. 6, 1961, issue of M/R.*





Stillman meets "Space Age" requirements with the same reliability and product perfection that has earned them a name for dependability throughout the aircraft and missile industry for many years. Stillman products fly with the jets. They are also integral parts of the fuel and hydraulic systems for many of the advanced weapon systems. Engineering, research and development, and progressive designing enable Stillman to meet the challenge of the space age.

**STILLMAN RUBBER COMPANY**

CULVER CITY, CALIF. / CLEVELAND, OHIO / ENGLEWOOD, N.J.

Circle No. 19 on Subscriber Service Card.


# new literature

SHAFT ENCODER—An eight-page technical brochure on shaft encoder translation is available from Harvey-Wells Electronics, Inc. The engineering-type discussion describes in detail the operation of the two basic models of shaft encoder translation equipment manufactured by Harvey-Wells Electronics. The two descriptions are supplemented by logical block diagrams and timing diagrams.

Circle No. 200 on Subscriber Service Card.

MICROWAVE—Microlab has made available a catalog of microwave components. This catalog consists of 72 pages and includes detailed descriptions and specifications of their line of coaxial attenuators, filters, power dividers, terminations, crystal mounts, tuners and other coaxial microwave components.

Circle No. 201 on Subscriber Service Card.

BLIND NUT—A solution to the problem of blind fastening is described in a product bulletin published by Standard Pressed Steel Co. It covers the SPS Davis press nut. The literature reviews the principle of operation of the unique one-piece, flush-mounting nut; suggests possible applications, principally in airframe, missile and comparable sheet metal applications; and details general specification data.

Circle No. 202 on Subscriber Service Card.

SEALED SWITCH—A one-page data sheet covering Catalog Listing 41HR1-S has been released by MICRO SWITCH, a division of Minneapolis-Honeywell Regulator Co. It includes details of construction, characteristics and electrical rating, and prices.

Circle No. 203 on Subscriber Service Card.

LEAKPROOF CHEMPUMPS—A four-page bulletin released by Chempump Division, Fostoria Corp., describes the Series G Chempump, its automatic thrust balance, extremely large bearings, oil-filled stator cavity and other exclusive features. Bulletin 2050 also includes complete performance curves and a detailed cross-section of a new line of canned pumps.

Circle No. 204 on Subscriber Service Card.

**Lucien J. Donadieu:** Formerly engaged n the development of a superconducting nagnet for the National Science Foundaon and M.I.T., appointed special conultant to Cryoflux program at Magnion, nc., Cambridge, Mass. **Milton Raymond** head Magnion's ultra-high-field pulsed nagnet design and **John Tracey** engaged or mechanical design of the new Plasmaux air core and Uniflux iron core magnet nes.

**Adm. Joseph J. Clark (USN-ret.);** Apointed executive director of Solitron Deices, Inc., Norwood, N.J.

**William R. Bidermann:** Appointed nief production engineer of Telecomputng Corporation's Whittaker Gyro Division, an Nuys, Calif. Among the missile proams on which the company is particiating are *Bullpup, Shillelagh, Polaris, Nike-Hercules, Skybolt* and *Nike-Zeus.*

**George C. Rayner:** Named assistant to e president of Allied Chemical's General hemical Division, New York.

**Robert R. Beachler, Jr.:** Corporate dictor of engineering, elected vice presint of Leach Corporation, Los Angeles, nd appointed general manager of the Re- y Division.

**August Nuut:** Named vice president of ngineering for special products at Ameri- n Missile Products Co., Inc., Los ngeles.

**T. L. Maltby:** Promoted to weapon stem manager—XKD2B-1/Q-12 missile rget system for Beech Aircraft Corp., ichita, Kan. **George R. Selig** appointed ecutive project administrator-all military ojects. **Ed C. Nikkel** appointed weapon stem manager-B-70 alert pod program, d **Roy H. McGregor** appointed man- er-contract administration.

**Maj. Gen. Albert Boyd (USAF-ret.):** ce president and general manager of estinghouse Electric Corporation's deise products divisions, honored with the ghest award the company gives its employees, the Order of Merit, for "vision d leadership which have inspired oughout Westinghouse a better underanding of defense and space problems." or to joining Westinghouse, he was puty Commander, Weapons Systems, adquarters, ARDC.

**Bernard B. Smyth:** Appointed assistant e president of General Atomic Division General Dynamics Corporation. He l be in charge of General Atomic's ce in Washington, D.C.

**Frank Seay:** Vice chairman of the IRECO '61 general committee and llas I.R.E. section representative to the IRECO board, appointed assistant to president of the Graduate Research nter in Dallas.

**Albert R. Conrad:** Appointed manager of Electro-mechanical Engineering, Computer Products Operations, at Ford Motor Company's Aeronutronic Division, Newport Beach, Calif. **Roger L. Sisson** appointed manager, Program Analysis, Technical Staff.

**Roy W. Murray, Jr.** and **Edward J. Weiss:** Named director of marketing and director of contracts, respectively, for Radiation Incorporated, Melbourne, Fla. Before joining the company, Murray was western regional manager for Tele Dynamics, Inc. and Weiss was consultant to USAF's Directorate of Weapon Systems while with the Wright Air Development Center.

**T. R. Finch:** Named assistant general manager of Motorola's semiconductor products division, Phoenix, Ariz. Before joining Motorola, he was special systems development engineer for Bell Telephone Laboratories, Murray Hill, N.J.

**Richard D. Moroney:** Former supervisor of balloon flight operations for General Mills, Inc., named project engineer for the G. T. Schjeldahl Co., Northfield, Minn., where he will participate in the company's stratospheric balloon and high-altitude research programs.

**Dr. Nathan Marcuvitz:** Appointed vice president for research at Polytechnic Institute of Brooklyn. Former director of Polytechnic's Microwave Research Institute and supervisor of its electrophysics group, he has also been for the last 12 years electrophysics consultant to NYU's Institute of Mathematical Sciences.

**George E. Holmes:** Placed in charge of SUBROC and rocket production planning and control for Goodyear Aircraft Corp., Akron, Ohio. **Henry H. Nettling** named assistant to Holmes.

**Harold B. Finger:** Appointed assistant director for nuclear applications in NASA's Office of Launch Vehicle Programs. He will continue as manager of the joint Atomic Energy Commission-NASA Space Nuclear Propulsion Office.

**William R. Corliss:** Engineer at The Martin Company's Nuclear Division, Baltimore, appointed consulting editor on propulsion for the McGraw-Hill Encyclopedia of Science and Technology. Before joining The Martin Company, he was an engineer on the aircraft nuclear propulsion program at Pratt & Whitney Aircraft and a space propulsion systems specialist for General Electric Co.




THE STANDARD OF CALIBRATION

A sensitive dead weight pressure balance for use as a primary pressure standard. Repeatability in excess of 0.01%.

Ranges up to 12,000 psi with subdivisions as small as 0.1 psi.

Designed to calibrate a wide selection of pressure-measuring devices, the gage is adaptable to almost any pressure-measuring problem. Complete pressure testing and calibrating installations assembled to meet customer specifications.

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RUSKA DEAD WEIGHT GAGE




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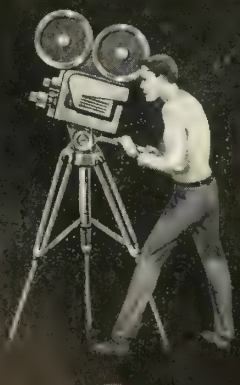


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Whatever your optical needs—Tracking — Reconnaissance — Plotting — Photo Interpretation — Mapping — the uniformly high quality of GOERZ lenses is your guarantee for reliable performance.

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C. P. GOERZ AMERICAN OPTICAL CO.
INWOOD 96, L. I., N. Y.

Circle No. 22 on Subscriber Service Card.

# letters

## Reviving Reliability

*To the Editor:*

You deserve a "well done" for your excellent editorial, "The Girl with the Soldering Iron" (M/R, Feb. 27). You put some life in the "tired" word "reliability."

Edward W. Locke
Director, Customer Relations
Defense Products Headquarters
Westinghouse Electric Corp.
Washington, D.C.

*To the Editor:*

Thought you might enjoy hearing that we intend to circulate copies—plant-wide—of the editorial "The Girl with the Soldering Iron."

It is a funny coincidence because in the next few weeks I will be shooting a movie here called "One Bad Solder Joint," depicting "Wanda" and her soldering iron, and how important she is to the success of our operation. I had been kicking the idea and the script around for about three months, and finally got the okay on it, so I really got a boot out of seeing the editorial.

Many thanks for the wonderful coverage and attention you gave us in the Guidance System edition.

Taylor Gates Benson
Public Relations Representative
AC Spark Plug Division
General Motors
Milwaukee

## MiniWeld Treatment

*To the Editor:*

We are pleased with the publication of the article on our MiniWeld Erector Set equipment (M/R, Feb. 27, p. 26). The treatment of the text and figures was excellent.

Paul N. James
Reports Section
Francis Associates
Marion, Mass.

## Chrysler's Autocollimator

*To the Editor:*

A great many of us at the Chrysler Corporation Missile Division read with much interest the article on the Twist Autocollimator optical alignment system scheduled to be used on the mobile *Minuteman* ICBM (M/R, Feb. 6, p. 33). However, we were somewhat disappointed that the article did not assign credit for the design and development of this unique system.

The Twist Autocollimator was designed, developed and currently is being produced by the Chrysler Missile Division for the Autonetics Division of North American Aviation, Inc. It is an outgrowth of several years of proprietary development work within our Advanced Development Branch performed under the direction of Dr. J. G. Gievers, one of the foremost authorities in optical alignment.

We are certain that MISSILES AND ROCKETS, and our customer, the Autonetics Division, would welcome the proper assignment of credit.

C. J. Weatherred
Manager, Program Development
Chrysler Corp. Missile Division
Detroit

## Credit for Plating

*To the Editor:*

I should like to set the record straight on some material printed in the Nov. 28, 1960, M/R, in an article entitled "Selective Electroplating Saves Time and Dollars."

In this article, you described a selective plating maintenance operation carried out on a group of missile launching valves on a submarine designed to carry the *Polaris* missile. My firm, Metachemical Associates, Inc., actually did the selective plating job and is thus in a position to correct several inaccuracies.

To begin with, the submarine was the USS Patrick Henry and not the USS George Washington. This is a serious factual error and should have been checked. Second, these valves are not "exposed to a hostile sea water environment" *per se*, as mentioned in the article but rather to other environmental conditions and variations.

Third, the thickness of the tin-indium specified was not 0.003 in., but varied from a flash plate on threaded areas to a maximum of 0.003 in. on certain sections of the valve . . .

Most important to us—and we believe to your readers—is the fact that full credit in the article was given to the manufacturer of the particular selective plating process, while no credit was given to Metachemical Associates, Inc., who originally surveyed the problem and engineered the solution described. Furthermore, our personnel worked around the clock for more than three weeks so as to complete the job and not delay Navy activities. In fact, our entire staff is proud of a letter of commendation we received for ". . . a job well done under difficult field conditions . . ." from Vice Adm. W. F. Raborn, Director of the *Polaris* Program for the Navy.

Herman R. Reade
Metachemical Associates, Inc.
Forest Hills, N. Y.

*That portion of the article containing "inaccuracies" was drawn from a press release approved and cleared by the Navy's Special Projects Office. Mr. Reade's comments have been verified by the Navy and we are pleased to set the record straight. To further assure full credit where due, we must mention that the consultant for the task was Marlane Development Co. of New York, which provided the Dalic Process plating equipment and engineering assistance. And a representative of Sifco Metachemical Inc., provided technical assistance to Marlane throughout the operation.—Ed.*

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**RE International Convention, Coliseum and Waldorf-Astoria Hotel,** New York City, Mar. 20-23.

**merican Society for Metals, 12th Western Metal Congress, Ambassador Hotel and Western Metal Exposition in Pan-Pacific Auditorium,** Los Angeles, Mar. 20-24.

**rd Annual American Power Conference,** Sherman Hotel, Chicago, Mar. 21-23.

**nerican Meteorological Society, General Meeting,** Chicago, Mar. 21-23.

**nerican Chemical Society, 139th National Meeting,** St. Louis, Mar. 21-30.

**ird Annual Symposium on Electron Beam Technology, Alloyd Electronics Corp.,** Boston, Mar. 23-24.

**n Symposium on Temperature, Its Measurement and Control in Science and Industry, sponsored by ISA, American Institute of Physics, National Bureau of Standards, Veteran's Memorial Hall and Deshler Hilton Hotel,** Columbus, Ohio, Mar. 27-31.

**nerican Nuclear Society, Nucleonics in Flight Symposium,** Statler Hilton Hotel, Dallas, Mar. 28-29.

**iety of Aerospace Material and Process Engineers, Filament Winding Symposium,** Huntington-Sheraton Hotel, Pasadena, Calif., Mar. 28-30.



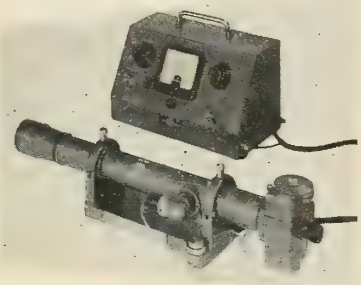
## Advertisers' Index


Aerospace Corp. . . . . 3
Agency—Gaynor & Ducas, Inc.
American Telephone & Telegraph Co. . . . . 4
Agency—N. W. Ayer & Son, Inc.
Arcturus Mfg. Co. . . . . 51
Agency—Anderson-McConnell Adv. Agency, Inc.
Callery Chemical Co. . . . . 39
Agency—Ketchum, MacLeod & Grove, Inc.
Consolidated Electrodynamics Corp. . . . . 36
Agency—Hixson & Jorgensen, Inc.
E. I. Du Pont De Nemours & Co., Inc. Explosives Div. . . 41
Agency—The Rumrill Co., Inc.
Edgerton, Germeshausen & Grier, Inc, . . . . . 19
Agency—Reach, McClinton & Humphrey, Inc.
Engis Equipment Co. . . . . 49
Agency—Central Advertising Service
Fenn Mfg. Co. . . . . 7
Agency—The F. W. Prelle Co.
C. P. Goerz American Optical Co. . . . . 48
Agency—R. E. McGuire Assoc., Inc.
B. F. Goodrich Aviation Products Co. . . . . 29
Agency—The Griswold-Eshleman Co.
Hallicrafters Co., The . . . . . 33
Agency—Henry B. Kreer & Co., Inc.
James, Pond & Clark . . . . . 45
Agency—Weir Advertising, Inc.
Johns Hopkins University, Applied Physics Laboratory . . 10
Agency—S. G. Stackig, Inc.
Kollmorgen Corp. . . . . 40
Agency—Wilson, Haight & Welch, Inc.
Librascope Div., General Precision, Inc. . . . . 2
Agency—Compton Adv., Inc.
Lincoln Laboratory—Massachusetts Institute of Technology 34
Agency—Randolph Assoc., Adv.
Lockheed Aircraft Corp.
California Div. . . . . 43
Missiles & Space Div. . . . . 20
Agency—Hal Stebbins, Inc.
Microdot, Inc. . . . . 35
Agency—Carson/Roberts/Inc.
Minneapolis Honeywell Regulator Co., Aero Div. . . . . 22
Agency—Batten, Barton, Durstine & Osborn, Inc.
Pan American World Airways, Inc., Guided Missiles Range Div. . . . . 31
Agency—Willard E. Botts Adv., Inc.
Ruska Instrument Corp. . . . . 47
Agency—Rives, Dyke & Co., Adv.
Sperry Farragut Co., Div.-Sperry Rand Corp. . . . . 37
Agency—Chirurg & Cairns, Inc.
Stearns-Roger Mfg. Co. . . . . 42
Agency—Mosher, Reimer, Williamson Adv. Agency, Inc.
Stillman Rubber Co. . . . . 46
Agency—McNaughton-Laub, Inc.
System Development Corp. . . 8
Agency—Fuller & Smith & Ross, Inc.
Varian Assoc., Radiation Div. . 52
Agency—Hoefer, Dieterich & Brown, Inc.
Wayne/George Corp. . . . . 11
Agency—Meissner & Co., Inc.
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# An Open Purse and a Shut Mouth

TENTATIVE STEPS now are being taken toward a large solid-rocket booster program which could serve as a backup to the *Saturn* liquid program. It is an effort which should receive all the financial support necessary to move it forward at optimum speed.

Those closest to the solid propulsion field believe a breakthrough has been made which now can be exploited. A number of firms have been studying and testing the feasibility of concepts in this field since 1959, under both Air Force and National Aeronautics and Space Administration contracts.

These include Aerojet-General, Thiokol, Grand Central Rocket and United Technology. Their approaches were based on work done earlier by these companies and others.

These studies all have pointed to the fact that a big solid booster should be developed, not as a substitute for the large liquid boosters, but as a complement.

Cost of such a program is relatively modest when matched against the possible gains. Best informed estimates are that it can be accomplished for $60-million or less.

A contract between United Technology Corp. and NASA is in the final stages of negotiation. This is for development of a single solid segment weighing 70,000 lbs. This would develop about 250,000 lbs. thrust on the basis of a 60-sec. burning time. This is the first NASA solid contract of any size. UTC is confident enough of success to accept the contract on a shared-cost basis.

This is not entirely altruistic, since there are hopes of a follow-on contract. First segment is scheduled for completion in about three months.

Meanwhile, NASA officials are preparing to lay before the Administration a request for a $15-million supplemental appropriation for a new segmented solid program. This calls for a competition in late spring which would lead to a contract award this summer for segments of up to 110,000 lbs. These would provide a thrust of some 400,000 lbs. on a 60-sec. burning time.

This program could be the big step toward a solid rocket as large as the F-1 liquid engine.

It offers a number of advantages. It would give the U.S. an alternative to *Saturn* in the event of a failure in that important program. It would lay the groundwork for further development of solids.

More important, here is an area of great promise in which it appears we definitely are ahead of the Russians. In the same way the U.S. built its early efforts around the Von Braun team, the Soviet Union leaned heavily on the German scientists it scooped up from Peenemunde and other German centers. Both countries thus concentrated initially on big liquid boosters. But there was a basic difference which often is overlooked.

The Soviet chemical industry is one of the weak spots in the Russian economy. Not only did the Soviets use the German scientists in rocket development, they depended on them for overall help in development of their chemical industry. They thus tied the industry in many ways to a 1945 level of scientific knowledge.

U.S. chemical and propulsion experts, meanwhile, pushed ahead on their own with development of new fields. In these, the Russians were left behind. The broad base of the U.S. chemical industry laid the groundwork for the breakthrough which now has taken place in solids. It should be exploited before the Russians catch up.

THIS LEADS to another important point. As the trade magazine of the missile/space industry, we are devoted to as wide an exchange of technical information as possible. In the long run, the U.S. gains more from this than it loses in making information easily available to the Soviet Union. The situation in regard to solid development, however, calls for a very careful attitude in regard to release of truly detailed technical information.

Technical meetings on solids should be closed to the Russians. Chemical equipment of value in this area should not be exported to them. Papers delivered at open meetings should be carefully scanned for technical security. While this magazine will be the first to complain at unnecessary censorship, we will support fully efforts to play this one as close to the vest as possible.

Exploit the breakthrough; keep our mouths shut. It's a policy that could pay off in the space race.

**William J. Coughlin**

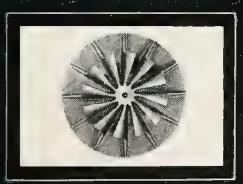
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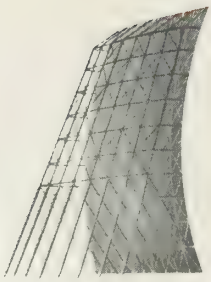
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MARCH 13, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

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*Adm. Hayward: 'Confidence through Blow-ups'*

Hayward Calls for More Training Shots .
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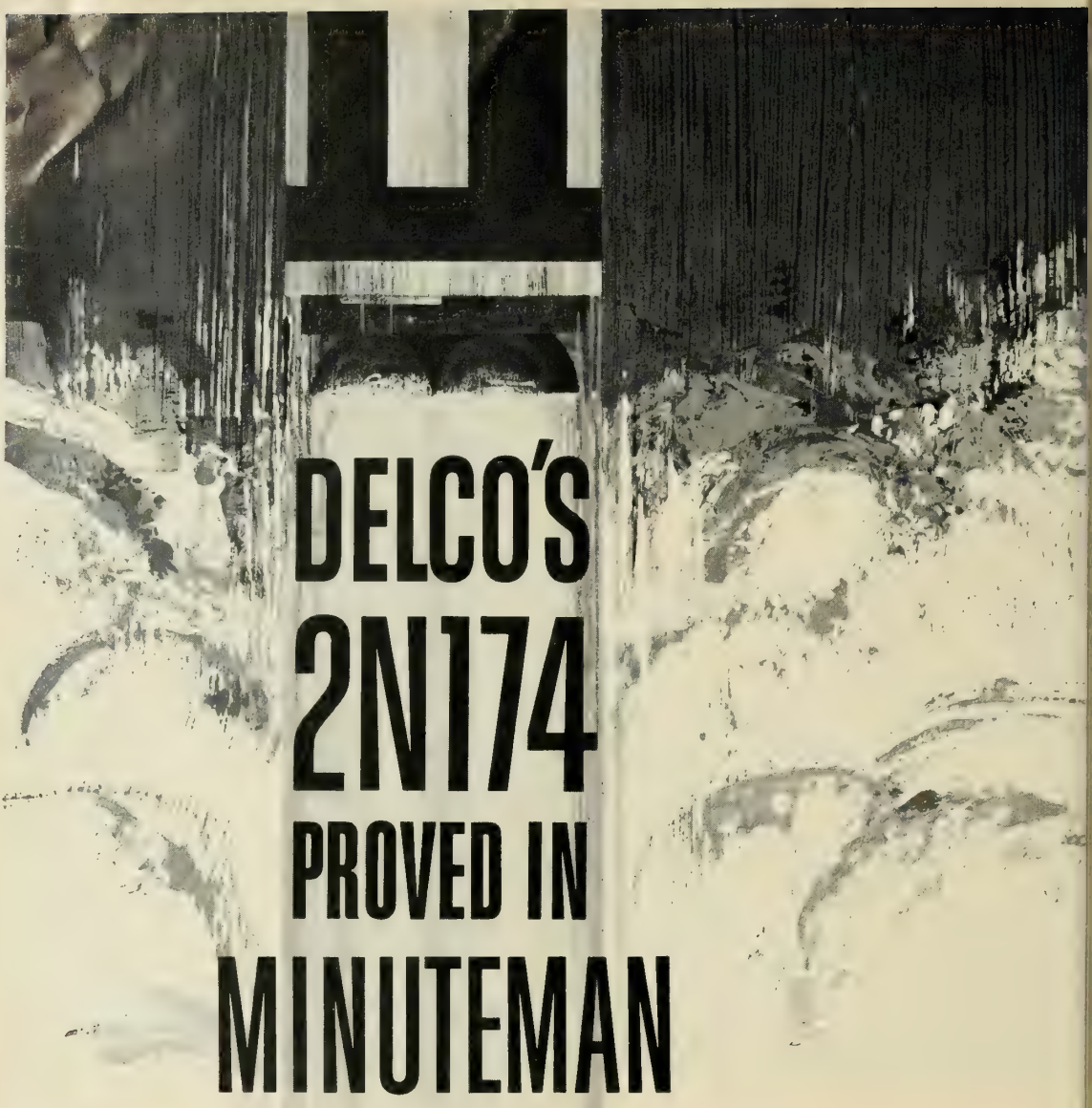
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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, No. 11 March 13, 1961

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## THE COVER

*Vice Adm. John T. Hayward, Navy R&D chief, says missile training shots must be sharply increased to guarantee reliability. See interview starting on p. 14.*

## MARCH 13 HEADLINES

Hayward Urges Big Step-up in Training Launches ... 14
Kennedy Administration Renews AF Space 'License' 16
Worldwide Weather Satellite System Blueprinted ... 17
Mace B Bases Near Completion on Japan's Okinawa 18
Lockheed's LMSD Wins Goddard Memorial Trophy .. 19
Orval Cook Says Contracting Must be Overhauled .. 19
Project Banshee to Study Explosions in Near Space .. 40
Blue Scout II Flies with Fourth-stage Guidance ..... 41
A Look at North American's Aerospace Laboratory .. 43

## SPACE MEDICINE

GE Develops 200-lb. Water/Oxygen Recycling System 22
NASA Maps Plans for Post-Mercury Manned Launchings ..... 24

## ASW ENGINEERING

Navy Getting First Target Submarine Simulators .... 28
Clevite's 'Oyster'—Rugged Undersea Transducer .... 29

## SUPPORT EQUIPMENT

GE's 'Synchrolink' Swells Telemetry Range ..... 30

## OPTICS

Will Laser Lead to Intergalaxial Communications? ..32

## ADVANCED MATERIALS†

Tapco Explores Tungsten Fabrication Techniques .... 36

## ELECTRONICS

'Limited War' Is Military Theme of EIA Meeting .... 38
Support Equipment Controlled by 'Audio-automation' 38

## MANAGEMENT

Tulsa Firm Expands Missile/Space Work by Stages .. 42

## DEPARTMENTS

Publisher's Memo .... 6
The Countdown ..... 11
The Missile/Space Week† ..... 12
Technical Countdown . 21
Reviews ..... 39
Names in the News .. 44
Products & Processes . 45
Contracts ..... 47
Letters ..... 48
When and Where .... 48
Editorial ..... 48

†U.S. Reg. Pdg.

*33,134 copies this issue*



*MILLS SHEPARD (at left) confers with M/R representatives in New York.*

# memo from the publisher

WHO ARE YOU, where are you and what do you read? We know, and we thought perhaps you might like to know how we find out.

Like Elmo Roper, George Gallup and Daniel Starch . . . Mills Shepard of Bronxville, N.Y., is a consultant in research. Some 20 businesspaper publishers in all fields of U.S. industry employ Mr. Shepard and his Associates each year to learn more about the readership of their magazines.

Among the publications which Mills Shepard studies are The Iron Age, Printer's Ink, Electrical World, Petroleum Week, Railway Age, Mill and Factory, American Builder and MISSILES AND ROCKETS.

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Here's where Mills Shepard come in. Six times each year, the Shepar organization sends a team of researcher into the field to talk to M/R sub scribers. When 150 field interview have been completed among people wh represent a cross-section of the mis sile/space industry, both geographicall and by job responsibility, the results o these interviews are compiled and sen to us for evaluation.

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Edward Mukefield

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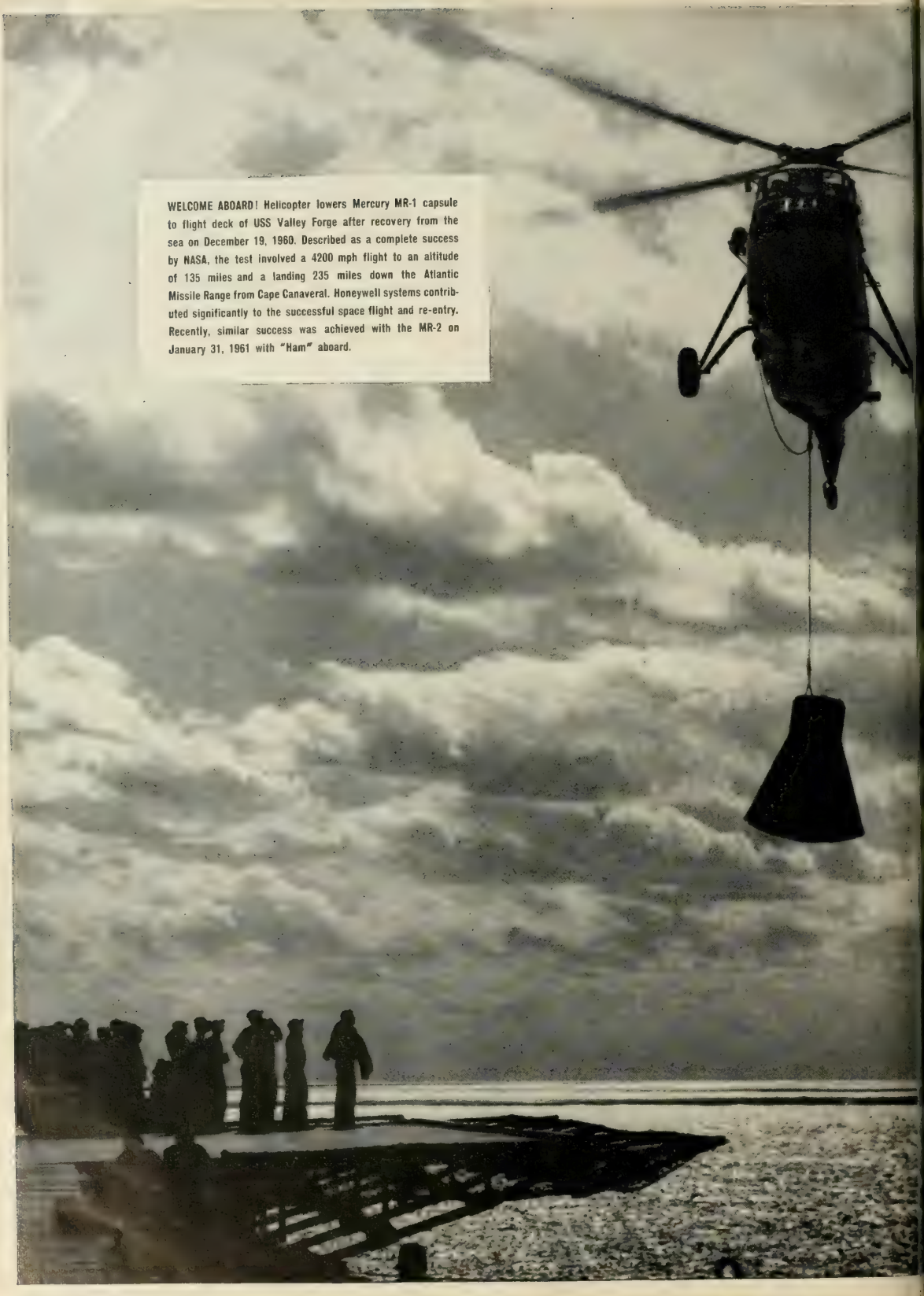
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**WELCOME ABOARD!** Helicopter lowers Mercury MR-1 capsule to flight deck of USS Valley Forge after recovery from the sea on December 19, 1960. Described as a complete success by NASA, the test involved a 4200 mph flight to an altitude of 135 miles and a landing 235 miles down the Atlantic Missile Range from Cape Canaveral. Honeywell systems contributed significantly to the successful space flight and re-entry. Recently, similar success was achieved with the MR-2 on January 31, 1961 with "Ham" aboard.



fficial NASA Photo

# PROJECT MERCURY: TWO STEPS FORWARD!

**Honeywell's Attitude Stabilization and Control System properly sequenced the orientation, deceleration and spinning, essential to the re-entry and safe landing of the Mercury MR-1 and MR-2 ("Ham") capsules.**

Project Mercury, NASA's initial manned space flight program, is rapidly nearing the stage at which an astronaut will ride the capsule. Preliminary stages of testing have resulted in refinements that will assure the astronaut's safety and comfort from take-off to touchdown. In the manned shot, just as in these successful tests, Honeywell systems are vitally involved.

Here is how Honeywell systems contributed to the success of the completed MR-1 shot shown at left. After a two minute boost from the Redstone missile, the capsule was separated. The Honeywell Attitude Stabilization and Control System damped out any initial tendency to tumble, in about five seconds, and held the capsule in the attitude of separation. During a five minute period of orientation the capsule was yawed around so that the blunt end (heat shield) was in the leading position. Also, by means of a Honeywell gyro, the capsule was oriented with the blunt end elevated 14° from a perpendicular to local vertical. Later this orientation was changed to 34°, and the retrorockets were fired for two minutes to reduce speed by 350 mph. The capsule was then aligned to a very shallow re-entry angle. Upon sensing a 0.05G deceleration, the system started the capsule spinning at a rate of 10°/sec. At 21,000 feet altitude, a parachute was deployed and the control system disconnected.

This carefully programmed sequence was sensed and controlled by extreme-precision Honeywell gyros and related circuitry in the system. Functions of the system were telemetered to the ground for study in preparation for the manned capsule flight. Additional information was gained from the "Ham" shot. The astronaut will have the option of using manual controls to override the automatic system control.

The manned flight will also carry a Honeywell Attitude and Rate Indicator System which provides the astronaut with information on capsule attitude, rate of attitude change and a reference for controlling attitude. A Honeywell Earth Path Indicator will provide continuous information of the location and direction of travel in relation to the surface of the Earth. A Honeywell Humidity Indicator will keep the astronaut posted on the humidity condition.

Project Mercury is just one of the important missile and space programs for which Honeywell is providing guidance, control and stabilization systems. Others include Centaur, Scout, X-15, Agena B, Thor-Delta and Polaris. Honeywell is also Prime Contractor on ASROC and Associate Prime Contractor on Dyna Soar. To learn how Honeywell can assist with systems integration and management programs, contact your nearest Honeywell representative, or write: Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13, Minnesota. *Sales and service offices in all principal cities of the world.*

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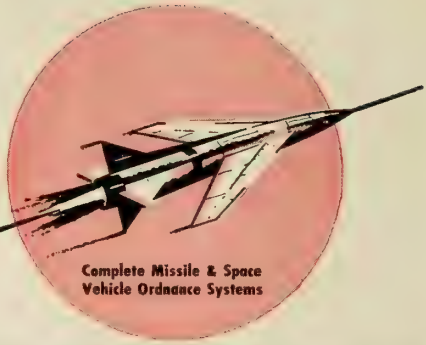
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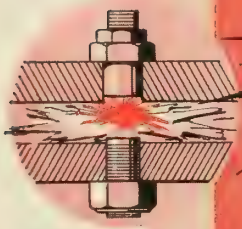


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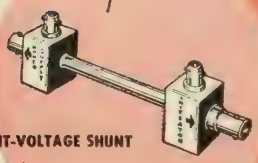
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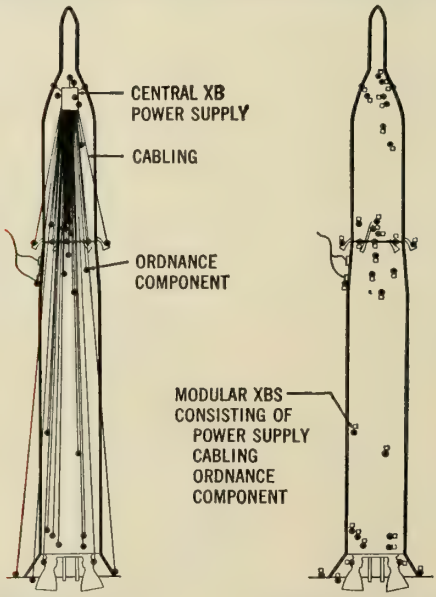
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# The Countdown

## WASHINGTON

### Votes for NASA

COUNTDOWN hears some powerful congressional figures are urging Kennedy to maintain a strong civilian space effort in NASA. The main reason: propaganda. Russia has succeeded in cloaking the military nature of its space activities. If all U.S. space programs are turned over to the military, the Russians will be handed the advantage as the "peaceful" space explorer in world opinion.

### McNamara Gets Warning Sign

Chairman Moss of the House Information Subcommittee is warning Defense Secretary McNamara there may be "grave danger" the public will get less DOD information under the Kennedy Administration. The sore point: McNamara's new investigation of the DOD information system, ordered as the result of recent news "leaks." In an exchange of letters, Moss said the investigation could bring about the imposition of outright "censorship."

### Is Anyone Listening?

Military men are ready to deny charges that they are not receptive enough to new ideas for weapons—a complaint being voiced by scientists. The House Space Committee is quite seriously concerned with the charge, and has ordered extensive staff studies which could lead to early hearings.

### Hearing Gaps and Missile Gaps

The Democratic-run Congress is not making any effort to hurry up public measuring of the Missile Gap. Actually, plans for all hearings that could become conspicuous are marking time until Kennedy points the way.

### Pershing Being Pushed

Big drive is on by the Army to move up to summer the operational date of the solid-fueled *Pershing*. Success of a new inertial guidance system in a March 3 shot may be the key to the speed-up. Original deployment date was late this year.

### Third Polaris Sub Almost Ready

The Robert E. Lee is expected to go on war patrol about Easter—increasing the number of *Polaris* subs standing guard off Russia to three. The Navy hopes to have several more on combat station this year.

### Long Beach Polaris Out

Word is being spread that Defense Secretary McNamara has killed the last-minute decision by Ex-secretary Gates to put eight *Polaris* missiles in the nuclear-powered cruiser Long Beach. The reason is the $55-million cost—which would buy half of a far less vulnerable submarine.

## INDUSTRY

### ICBM Base Cost: $1.3 Billion

Figures made available by Congress this week estimate the total ICBM base construction cost (brick and mortar only) at $1.3 billion. The breakdown: 13 *Atlas* squadrons—$475 million; 14 *Titan* squadrons—$602.6 million; 9 *Minuteman* squadrons—$240 million. All of the *Minuteman* money is based on a cost of about $500,000 per silo, a figure which is being revised. About $246 million remains to be obligated to finish *Atlas* and *Titan* base construction—including $75 million for two *Titan* squadrons at Griffiss AFB, N.Y.

### New Competition: Glass Motor Cases

Number of companies developing a glass wrap capability is on the rise. This is borne out by the array of manufacturers—Rocketdyne, Allison and others—who are competing to second-source the second stage of *Polaris A-2* which is now being produced by Aerojet for Hercules.

### R&D Intelligence

Latest suggestion for solving the problem of moving large quantities of helium around the country to ICBM bases is to liquify it (at –452°F). This would eliminate bulky pressure tanks and reduce losses through leakage . . . Research to make beryllium more workable is on the upswing . . . Goodyear has come up with an inflatable fabric doughnut-shaped ring to cushion a space vehicle for a lunar or planetary landing . . . North American Aviation is pushing research on refrigeration systems to prevent an astronaut from broiling in the 213°F heat the sun produces on the moon.

### Thought of the Week

To any company thinking of "getting in" defense work there is this word of advice from Westinghouse Vice President E. V. Huggins: "Misguided enthusiasm to take on military work just for the sake of having it in-house can be destructive to both the contractor and the military. Above all, a company must put its effort where it will do the most good for the country . . . Military business cannot take second place to the commercial—if you want to stay in it."

## INTERNATIONAL

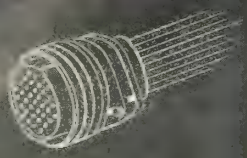
### New Steam for NATO MRBM

Expect NATO governments to take a step soon toward acquiring a medium-range ballistic missile—either *Polaris* or *Pershing*. The deciding factor appears to be the swing behind President De Gaulle's view that NATO can no longer rely as fully as it has on U.S. strategic nuclear forces in a purely European war.

### Overseas Pipeline

Japan is getting inquiries from Argentina, Burma and Australia on possible purchase of its *Kappa-6* sounding rockets for weather research . . . Britain will control the nuclear warheads for the *Skybolts* it buys from the U.S. —by using its own . . . Rumors are spreading that the Royal Air Force will soon scrap the air-to-air *Firestreak* . . . NATO representatives are debating whether they should buy Nord-Aviation's *Bullpup*-like *AS-30*.

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# The Missile/Space Week

## House Okays NASA Funds

A supplemental Fiscal Year 1961 appropriation of $49 million for NASA is before the Senate.

The House—traditionally the toughest Congressional stumbling block—approved all but $606,000 of the $49.9 million sought by former President Eisenhower for NASA R&D along with his FY '62 budget proposals.

The House left it to NASA to decide where to apply the "token" reductions. It also approved $500,000 of a $1-million request for additional authority to spend already-appropriated funds on travel.

Meanwhile, a NASA spokesman predicted work will be completed this week or next on revising the FY '62 budget to conform with the new Administration's requirements.

## Satellite Debate Stirs

Two giants of the communication business—American Telephone & Telegraph Corp. and the Radio Corp. of America—are at odds about the best technical approach to a commercial communication satellite system.

In briefs filed with the Federal Communications Commission last week, RCA came out for 24-hour-orbit synchronous satellites at 22,300 miles altitude, while AT&T renewed its proposal for satellites in 1000-3000-mile orbits, which it already has temporary FCC authority to operate. Both companies propose active repeater satellites.

Several other companies proposed in briefs that the ultimate system of commercial satellites should be owned jointly by all common carrier concerns using the facilities. The Justice Department, moreover, questioned whether single ownership would violate antitrust laws.

Meanwhile, Space Technology Laboratories won a three-year $2.7 million Army contract to provide systems engineering support and technical consultant services on Project *Advent*, the Army's program for developing a military 24-hour communications satellite.

And in a speech Tuesday, Richard S. Morse, assistant Army secretary for research and development, said a review of Army and National Aeronautics and Space Administration plans will be necessary to make certain duplication is avoided.

## X-15 Pilot Breaks Record

Maj. Bob White became first to fly four times the speed of sound when he guided his *X-15* to top speed of 2905 mph.

NASA said he flew the 57,000-lb.-thrust engine at two-thirds throttle.

Next flight, scheduled to be made by NASA pilot Joe Walker, may test altitude capability of the larger engine.



*RCA'S PROPOSED communications satellite shown in artist's conception.*

## Patrick Henry Reaches Loch

A new underwater record of 66 days, 22 hours, was set by *Polaris* sub Patrick Henry on patrol in the waters of Russia.

The sub emerged at Holy Loch, Scotland, in the midst of demonstrations by Scottish pacifists. The sub tender Proteus arrived at Holy Loch last week.

Now on station is the *Polaris* fleet sub George Washington.

## Probe Lost for Lack of Data

Russia's loss of contact with her Venus probe at less than 4 million miles leaves the long-distance radio communication record with the U.S. —by a factor of five.

The Soviet news agency Tass said Russian trackers failed to establish contact Feb. 27, just 15 days after launching.

The 250-ft. dish at Britain's Jodrell Bank tracked America's *Pioneer V* out to 22½ million miles last year. Dr. A. C. B. Lovell, observatory director, said the Soviets never gave him enough information to track their probe successfully.

Meanwhile, NASA gave these elements for the probe's orbit—calculated by other U.S. agencies on the basis of Russian statements: period 300 days, inclination 0.3 degrees to ecliptic, aphelion 1.019 astronomical unit, perihelion 0.7183 a.u.

## 'Big Boy' Igniter Disclosed

An igniter developed for Air Force's Project 3059 and other million-lb.-thrust class solid boosters is a 50,000 lb. thrust device dubbed "Big Boy."

Aerojet-General Corp. reveals the pyrotechnic device was used to ignite its 400,000-lb.-thrust "Bimbo" motor, a sub-scale segemented solid rocket. The igniter, which is 30 in. long, fired a controlled flame down the center of the core. A 70,000-lb.-thrust igniter is currently in the design stage by Aerojet for bigger motors.

## Three Years in Space

*Vanguard I,* the smallest satellite (though one of those most useful to science, is completing its third year in orbit still beeping away.

The solar-powered signal from the 3¼-lb. aluminum sphere has enabled trackers to follow its path in extremely fine detail, permitting geophysicists to gather a rich harvest of new information about the earth and the characteristics of the space since it was launched March 17, 1958.

The *Vanguard* program, which cost $95 million, also produced some fallout in the form of technology applied to further rocket programs and retooling the Atlantic Missile Range from missile development to space.

Scientific results include:

–Discoveries that the earth is slightly less oblate than previously believed, and that there is a pear-shaped distortion raising the sea level at the north pole 100 ft. higher than at the south pole.

–Proof that the orbit of a satellite is affected by solar wind, the pressure of sunlight, the earth's magnetic field, the wispy atmosphere above 400 miles and the gravitational fields of the sun and moon.

As for rocket technology, *Vanguard* provided a second stage widely used in the *Able* programs and still in use with modifications as *Delta* and *Able Star* and a third stage used in *Scout,* which pioneered development of high-energy final stages for the *Polaris* and *Minuteman* missiles. The first *Vanguard* third stage was the largest solid rocket of its day.

*Vanguard* pioneered the technique of coasting between stage firings, designed to obtain more circular orbits—something Russia never attempted until its orbital launching of the Venus probe last month.

Firing the first solid rocket in space, *Vanguard* learned about "chugging"—the tendency of solids to ignite for a brief burst sometimes several minutes after burnout. It was a "chug" from the final stage that bumped the rocket case against *Vanguard II* and caused it to wobble, spoiling the signals.

## CV Gets Saturn Tanks

Chance Vought Corp., Dallas, Tex., will manufacture 42 tanks of 70-in. diameter for *Saturn* boosters 6 through 10.

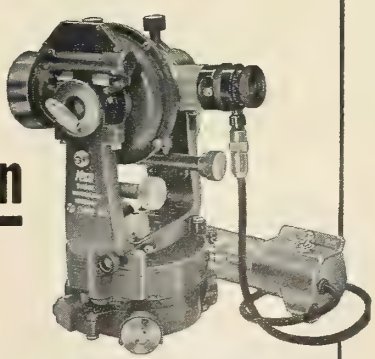
The National Aeronautics and Space Administration chose Chance Vought last week for negotiations on a contract estimated at $2 million, calling for delivery beginning in April 1962. The three other final bidders were Boeing Airplane Co., the Martin Co. and Chrysler Corp.


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# Hayward Urges Big Step-up I

**by James Baar**

VICE ADM. John T. Hayward, Deputy Chief of Naval Operations for Development, is urging a sharp increase in the current rate of missile training shots in order to ensure reliability in time of war.

"If the country is going to put confidence in its missiles, we have to be able to operate the systems more than we are," Hayward said in an interview with MISSILES AND ROCKETS. "We simply have to fire more missiles."

The admiral's statement underlined a key problem that has deeply concerned top officials in both the Navy and Air Force. At the same time, the admiral pointed to other significant R&D problems and trends. He said:

–"We must get a cheap HE surface-to-surface missile or we may have to go back to guns in the 1965-75 time period. We have discussed this with industry at great length. So far we have not been able to get one. The Russians have air-breathing surface-to-surface missiles. Maybe we were wrong in getting rid of ours so fast."

–"Communications may be the real answer to ASW. The ship, the plane and the sub each have individual qualities that the other two do not. If the sub can talk to the ship and to the plane as a closely knit team we may have what we need."

–"The solution to the sub-launched missile certainly is not apparent. *Typhon* is the first system to have any capability against a sub-launched missile. But the problem is very tough. For example, if a sub 35 miles away launches a missile at your ship you have to acquire and shoot down that missile in 27 seconds. There is the controlling factor."

–"More and more nuclear-powered surface ships are going to be built because nuclear power is going to become economically competitive from a military standpoint. On the other hand, the manned airplane is going to remain. The flexibility of man is most important. You have to be able to deliver with preciseness and flexibility which a missile does not possess. You don't want to incinerate your friends."

• **Training scoreboard**—Hayward talked easily in his usual forceful, blunt tones as he sat in his office on the Pentagon's top floor. Pictures and models of Navy missiles and aircraft decorated the room. Behind him on the wall was a dartboard labeled: "Top Level Decision Maker." It was divided into diamonds marked "yes" and "no."

While talking, the 52-year-old admiral leaned slightly forward in his chair and made short swivels back and forth. He gave the impression of being a tightly coiled, high-precision administrator tooled according to his own design. Two essential components obviously were brains and a sense of humor.

Hayward returned several times t the need for more missile training shot

At present, the number of big stra tegic missiles provided by the defens budget for training launchings is ver limited for economy reasons. Eac *Polaris* costs about $1.1 million; eac *Atlas*, about $2 million. The fund available do not go far.

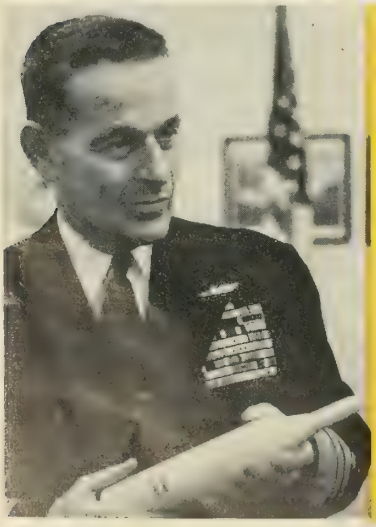
In all, there have been only nin *Atlas* training shots since the first o Sept. 9, 1959, from Vandenberg AF Calif. Five were successful; one, pa tially successful; three failed.

Only 15 *Polaris* training shots hav been launched since the first off Cap Canaveral on July 20, 1960. All 1 cleared the surface of the sea after b ing fired from submerged submarine Ten made successful flights; five faile

• **Data demand**—As a result of th paucity of operational training launche many military men including Haywar feel that the military crews are unab to gain sufficient confidence in the mi siles that they man. Moreover, there the problem of obtaining sufficient pe formance data from operational launc ings in order to plan targeting and d ploy sufficient forces to accomplis missions.

In the opinion of some, the secon need is far greater than the first. A one Air Force official put it:

"We don't really need to launch missile to train a man. Once he has the match I say he has done it. But th



- ***Either the Navy gets cheap HE missil or "we may have to go back to guns"***
- ***The antimissile problem: ships given only 27 seconds to react against sub***
- ***Look for more surface ships to be nuclear-powered; the airplane will stay***
- ***AF also worries about the reliability factor--could fire more missiles***

# CBM Training Shots

lecision makers have to have per-ormance statistics in order to have any onfidence in a weapon. The weapon as to be statistically reliable.

"In other words, I'm not going to ull a bomber out of the force and re-lace it with four or five missiles unless know the missiles are going to do he job. Only data from many opera-ional firings will tell me that a missile s going to work and how reliably. Otherwise I'm only operating on a de-igner's assurance."

Others disagree that actual launch-ngs are unnecessary for training in self.

"It's a matter of practicing opera-ion of a weapon under combat condi-ions or conditions as close to combat s possible," one officer said. "The nore you do it, the more confident ou are that you can. More unknown ugs are removed. And the whole ystem becomes more reliable. Turn around and the picture is precisely hat you think it would be."

Practicing this kind of training ould be very costly—conceivably run-ng into hundreds of missiles.

• **Lesson in torpedoes**—*Polaris* sub-narines coming in from their stations an stop at Cape Canaveral and their nissilemen can use their own equip-nent to launch a number of the mis-iles that they have been maintaining. For all practical purposes, such launch-ings can be done under combat condi-tions.

The closest that the Air Force can come to this is to ship missiles and the crews that have been maintaining them back to Vandenberg. Then the crews would launch the missiles with similar equipment.

Hayward said the training shot problem today is comparable in many ways to the torpedo problem that existed before World War II.

"Torpedos then were so secret and so expensive that we just didn't launch many of them," he said, shrugging. "The results were not good after the war started."

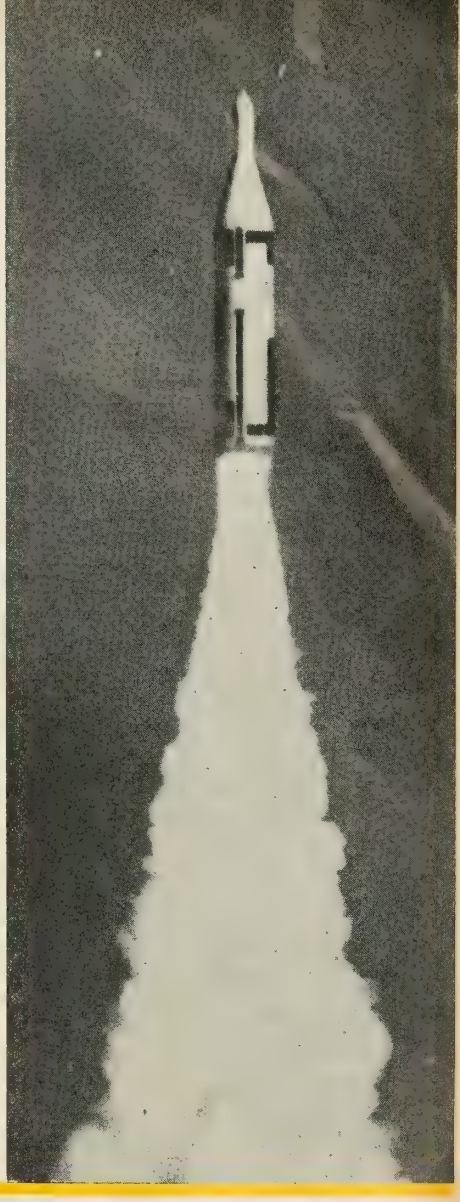
Hayward's statement was nothing if not kind. The results actually were disastrous.

"United States torpedoes were vari-ously described as running too deep, not exploding, exploding too soon, or not packing enough punch when they did explode," according to an official Navy report.

At another point the report said: "The problem was compounded by the Bureau's (Ordnance) reluctance to ac-cept the fleet evaluation of its weapon. This reluctance was born . . . from mis-placed confidence in its own past work."

Hayward pointed the moral suc-cinctly.

"To be sure of what you have, you have to let it go all the way and blow up. Frequently." ⌗



## Hayward Next CNO?

NOT LONG AGO one of the Navy's ig P2V Neptune patrol bombers roared rom the deck of the Carrier Midway in perfect takeoff, but when the pilot pre-ared to land again he was ordered to let he co-pilot do it.

The Navy's reasoning was sound. The ilot was too valuable to the Navy to ake unnessary risks. He was Vice Adm. ohn T. Hayward, Deputy Chief of Naval perations for Development and widely onsidered to be one of the top candidates o succeed Adm. Arleigh Burke as the ext Chief of Naval Operations.

The admiral who stuck his grizzled rew-cut head out of the Neptune and hen jauntily swung down onto the Mid-way's deck had been designated a naval aviator since 1932. Since then he has flown more than 13,000 hours.

During World War II, Hayward com-manded a bombing squadron and was awarded a Distinguished Flying Cross and Purple Heart. But in 1944 his career took one of its most significant turns. He be-came an experimental officer at NOTS, Inyokern, Calif., where he worked on rocket projects and the atomic bomb. It was the beginning of his naval career as a noted nuclear physicist.

Before becoming head of all Naval R&D in 1957, Hayward moved back and forth between technical assignments and sea duty. Among other posts he worked for the AEC and commanded the Naval Ordnance Laboratory.

Hayward is known for putting in gruelling days that begin about dawn and run into the night. He invariably carries stuffed briefcases home to his quarters at the Naval Weapons Plant where he lives with his wife and three children.

Another Hayward specialty is his an-nual series of appearances before con-gressional committees. His comments are always succinct, informative and often bloody.

Hayward has always been a good ath-lete. At Annapolis, he became an All-American water polo player. These days he confines himself mainly to playing par golf. He plays a good game both physically and psychologically.

"His golf is always better because yours is worse," one Naval officer who often plays with him grumbled recently. "It's decided before he tees off who is going to win." ⌗

# McNamara Renews Air Force Dominance of Military Space

***New directive gives AF job of directing 87% of DOD's space effort; some Army & Navy plans may suffer***

DEFENSE SECRETARY Robert S. McNamara has renewed and strengthened the Air Force's license as the nation's central and all-but-sole military space agency.

McNamara put in an official directive what has been fact for some time: Almost all military space programs—87%—are under the direction of the Air Force.

The proposed FY '62 defense budget provides $850 million in obligations for astronautics. The Air Force will pass out 91% of this either for itself or other agencies.

The McNamara directive assigned RDT&E for all future space development programs or projects to the Air Force—with only one loophole. It said that he or the Deputy Defense Secretary might make "exceptions . . . in unusual circumstances."

The directive specifically authorizes all three services "to conduct preliminary research to develop new ways of using space technology to perform . . . assigned functions."

But it was made clear that "preliminary research" would be tightly controlled by the Defense Director of R&E to make sure that it remained preliminary. The principal weapon here will be control of funding.

The directive said that all proposals for space R&D projects beyond the preliminary stage must be approved by the Defense Director R&E and the Defense Secretary. Once approved, the projects will be passed on to the Air Force.

McNamara said in a sparate memorandum to the Pentagon top command that the assignment of space R&D projects to the Air Force "will not predetermine the assignment of operational responsibilities for space systems." However, he said such assignments will "take into account the competence and experience of each of the services and the unified and specified commands." Since the Air Force would be the developer, its "competence and experience" seemed to give it something of an edge.

The new directive will not affect the Navy's *Transit* navigation satellite or the Army's *Advent* communications satellite R&D programs—the only major military satellite programs outside the Air Force. But the directive appeared to undercut a number of new space programs that the Army and Navy have had in mind.

• **Possible casualties**—The most prominent among these are the anti-satellite proposals and studies that both the Navy and Army have been reviewing. The Navy has proposed the development of a seaborne anti-satellite missile. The Army has considered the conversion of *Zeus* batteries to anti-satellite work.

Both services also have considered the development of their own reconnaissance satellites. And the Navy has pressed for development of a satellite launch ship possibly equipped with *Polaris* boosters.

It was not immediately clear whether any of these projects might come under the "unusual circumstances" category.

The McNamara directive was described as a "further projection" of a policy memorandum issued by Defense Secretary Neil McElroy in 1959. The McElroy memorandum gave the Air Force the responsibility for the development, production and launching of military space boosters. But the assignment of payloads was to be made among the services. As it turned out, *Transit* and *Advent-Courier* were the only ones ever assigned outside the Air Force.

McNamara said in his memorandum that he issued this space directive to achieve "better organization and clearer assignment of responsibility." He said he felt this would "much improve . . . the military portion of the national space program."

A number of Navy and Army officers said privately that the directive might lead to some economies but it also would tend to slow up the development of any space system not clearly designed for the Air Force.

As one official put it: "Can't you see the Air Force knocking themselves out for a Navy project if an Air Force project is in need of attention?"

The directive generally followed a recommendation made earlier in the year by President Kennedy's Ad Hoc Committee on Space. The committee said "a single responsibility within the military establishments for managing military portion of the space program" should be named.

Now that McNamara has done it the question that arises is how much of the overall national space program the "single responsibility" will be given by the Kennedy Administration.

Some indications are expected to come when Kennedy sends his new defense proposals to Congress—probably within the week. ‡

## Probers Score Base Costs, Delays

HOUSE INVESTIGATORS are standing firm for the present method of lump-sum contracts for construction of ICBM bases.

The pleas of base-builders for "cost-reimbursement-type" contracts were brushed aside by the House Appropriations Military Construction Subcommittee, which has been holding hearings on rising costs and lagging completion dates of ICBM bases (M/R, March 6, p. 14).

The House probers say the lump-sum approach sets realistic prices—and both the Defense Department and its contractors should therefor strive to live with it.

Both DOD and the contractors have been chastized during the hearings. The Committee declared that the heart of the problem was "division of responsibility" coupled with an "abnormally large number of change orders." It called for Pentagon appointment of a single, overall director of the huge missile-base program.

"Congress has made available in excess of $1.5 billion for this construction," the Committee said. "The Fiscal Year 1962 budget contains a reques for $251,900,000, and undoubtedly additional funds will be required in Fiscal Year 1962 and in future years."

To help contractors work under the lump-sum method, the Committee recommended that closer coordination be established between the designer and manufacturer of equipment and the design and construction personnel. It decried ivory-tower estimates of costs and called for estimates by professionals familiar with the problems involved.

The military was advised to let the builders know when design changes appear probable, so that the construction schedule can be altered if necessary at the least cost to the taxpayer. In addition, the Committee said, realistic cost estimates of changes must be made before they are actually undertaken.

The investigators recommended that every major change be brought up at a conference where all interested parties are represented. At this gathering it said, everyone involved should consider the effects of the change on cost and on the construction timetable.

*$100 million a year . . .*

# Weather-Satellite Birth Pains

***Plans for U.S.-operated worldwide systems must win approval of committees, President and Congress to be operational by FY 1963***

**by Jay Holmes**

AN INTERAGENCY committee opes to blueprint within the next few eeks an operational worldwide weather atellite system—to be run solely by the Inited States until such time as there international agreement. The cost robably will exceed $100 million a ear.

A subcommittee of the National oordinating Committee for Aviation Ieteorology (NACCAM) which is do-ig the work is headed by Dr. Francis *V.* Reichelderfer, chief of the U.S. Veather Bureau.

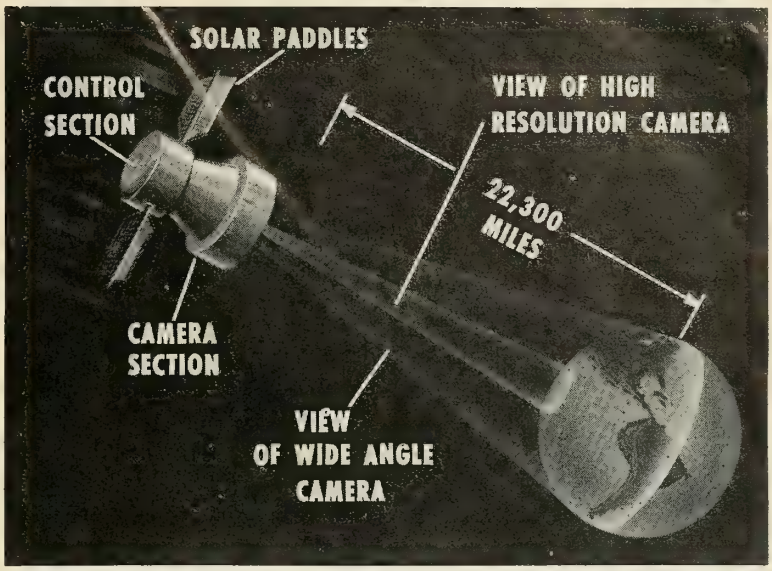
Upon agreement of the agency eads, the program will go to President ennedy or—if it is in operation by at time—to the National Aeronautics nd Space Council, which Vice Presi-ent Johnson is expected to head.

The plan undoubtedly will require ongressional action. In addition there ill be the need for funds. Committee embers decline to make even "ball-ark" estimates of the amount. How-ver, some officials close to the com-ittee believe it will require about $10 illion in Fiscal Year 1962 and up-ards of $100 million a year when it vings into complete operation, prob-bly in FY '63.

NACCAM consists of the heads of e meteorological services of the three ilitary services and the Federal Avia-on Agency, Edgar M. Cortright of the ational Aeronautics and Space Ad-inistration and Reichelderfer. The bcommittee, designated the Panel on eteorological Satellites (POMS), is aded by Cortright. Dr. Morris Tep-r, NASA chief of meteorological tellites, also sits on POMS.

• **Many-layered labyrinth**—Tepper ld the Senate Space Committee re-ntly that POM's is "charged with de-loping a specific technical and man-ement plan for the development, plementation and operation of a na-nal operational meteorological satel-e system."

The NASA official pointed out that ACCAM and POMS represent only e of several routes by which inter-ency committees have jurisdiction over the weather satellite program. Scientific advice comes from the Committee on Meteorological Aspects of Satellites of the Space Science Board of the National Academy of Sciences.




*ARTIST'S CONCEPTION of NASA's projected Aeros meteorological satellite, which is slated to carry a zoomar-type TV camera into a* BD*-hour equatorial orbit.*

The research and development work, including interim operational use of the weather data, is coordinated on the working level through the Joint Meteorological Satellite Advisory Committee, which includes representatives of NASA, the Department of Defense, the three services and the Weather Bureau. At the policy level, coordination between the DOD and NASA is provided by the Unmanned Spacecraft Panel of the Aeronautics and Astronautics Coordinating Board.

Unless the Kennedy administration can find some way to cut through the labyrinth of committees, final approval of any program that emerges from the technical working group is likely to take several months.

It is expected that the operational satellite system will be based on the second-generation *Nimbus* satellite, which is scheduled for first flight in the latter half of 1962. However, some of the data-distributing techniques may be tested on *Tiros III,* to be launched during the hurricane season this summer, and *Tiros IV,* a recent addition to the program, scheduled for next winter.

• **Operational when?**—The first two *Nimbus* launches will be designed to prove out the spacecraft's basic design. The following two on the R&D program will be designed to test advanced instruments to be carried, such as radar for information on areas of precipitation, a radiation spectrometer for data on the atmosphere's temperature structure and a sferics detector to identify thunderstorm areas.

NASA is not saying at just what stage operational launchings might begin. However, a logical time might be immediately after the first two launchings—so that full operation might begin with the basic satellite while research continues on advanced components.

In a paper prepared before POMS began its deliberations, a group of Weather Bureau scientists, headed by

*(continued on page 34)*

*Calculated risk . . .*

# Mace B Bases Readied on Okinawa

by Frank G. McGuire

NAHA, OKINAWA—Bases now are nearing completion for Air Force *Mace B* missiles with nuclear warheads, scheduled to become operational on this island during 1961.

The decision to base nuclear weapons on Okinawa—technically still Japanese soil—contained a calculated risk of major international political repercussions but these so far have not developed.

Although the U.S. occupies and completely controls the island, the government's official position is that the island is Japanese and will revert to that nation in time under our policy of residual sovereignty.

The nuclear-tipped *Mace B* missiles, scheduled for deployment in at least four sites on the island, have a 1200-mile plus range, bringing Communist Chinese industrial complexes within easy striking distance.

Fearful of repercussions in Japan, the U.S. deliberately has played down the bases. M/R received strong indication that responsible Japanese government officials aware of the program approve of it.

Plans to deploy *Mace* to the island first were disclosed early in 1960 by Defense Secretary Thomas Gates and Gen. Nathan F. Twining, Chairman, Joint Chiefs of Staff, in testimony before the House appropriations subcommittee. Gates gave the operational date as December, 1961. Portions of the testimony were censored.

After that, a press release concerning the installations was prepared by the Department of Defense, M/R has learned. Following clearance through all security agencies concerned, the release was killed at the last minute due to fear of political repercussions.

Headquarters, Pacific Air Forces, and the U.S. High Commissioner on Okinawa still refuse to comment on the program.

The deployment will mark the first time the U.S. is known to have permanently based such weapons on Japanese soil. Previously, Japan's rejection of all nuclear weapons, even in its own arsenal (M/R, October 17, 1960, p. 39) was enough to keep U.S. nuclear arms out.

Until recently, American strategic planners have considered the Far East almost devoid of major targets for long range missiles with large-yield nuclear warheads. The buildup of industrial complexes in China is beginning change this picture drastically.

With no strategic ballistic missil in the Far East, and SAC strength r portedly limited to one B-47 wing Guam, there is only limited U.S. n clear strike force capability represente by tactical F-100D, F101A, A3D ar other aircraft of the 5th and 13th A Forces, and the Navy's 7th fleet.

There is no counterpart in Asia the *Thor* in Britain, *Jupiter* in Ita and Turkey, *Polaris* on station, or t B-52 bases surrounding the USSI Any long-range weapon such as B-5 or *Atlas* could reach the Far East, course, but the Asian situation does n call for this heavy a weapon yet.

Military planners say the *Mace* r quirement developed because there no adequate substitute for having sizeable heavy nuclear strike force 35 miles off the China coast.

Formosa does not fill the bill b cause we do not have complete co trol over it and its armed forces. Th nuclear-armed tactical bomber win scattered through Okinawa, Korea an the Philippines could easily use som beefing up and support, now tha target size, dispersion and air defens have all increased in China.

• **Birds should be ready**—The thir flight test of a *Mace B* from a har site at Cape Canaveral took place suc cessfully in October, the flight test pr gram began two years ago. Air Forc says the vehicle's test program has bee highly successful, and the Tactical Ai Command began training with it i November.

By the time the sites on Okinaw are complete, *Mace B* should be read for them.

Martin Co., prime contractor fo *Mace B*, says the weapon's increase range over its predecessors, *Matado* and *Mace A*, is due to better utiliza tion of internal space, thus allowin a greater fuel load.

Using all-inertial guidance, instea of the *Matador's* radar control syste *Mace B* does not need the assistanc of a ground station such as that main tained in the Pescadores Islands fo control of *Matadors* launched fron Formosa.

*Mace B* has a ceiling of ove 40,000 feet, a cruise speed of ove 650 mph which becomes supersoni in its terminal dive on target, and launch weight of 15,500 lbs.




*OKINAWA-BASED Mace B's with 1200-mile-plus range could reach 850 miles into mainland, to Chungking or even Soviet Vladivostok. Thor would add 300 miles.*

# Goddard Trophy Goes To LMSD

***Award will be a highlight of the National Missile/Space Conference; Webb to speak***

WINNER OF the annual Dr. Robert H. Goddard Memorial Trophy for outstanding achievement in the missile/space field is the Lockheed Missiles and Space Division.

The award was made to LMSD for its work on the *Discoverer* and *Polaris* programs. Winner of the trophy is selected each year by the editorial staff of MISSILES AND ROCKETS magazine.

The trophy will be accepted by Herschel J. Brown, vice president and general manager of LMSD, as the highlight of the Goddard Memorial Dinner on March 16. The dinner is held as part of the National Missile/Space Conference sponsored by the National Rocket Club. More than 800 persons are expected to attend.

The trophy will be presented by William J. Coughlin, editor of MISSILES AND ROCKETS. Principal speaker at the dinner will be James E. Webb, making his first public address since taking office as administrator of the National Aeronautics and Space Administration.

Speakers at luncheon sessions of the March 14-17 conference will include Vice Adm. William F. Raborn, chief of the Navy's *Polaris* team, and Dr. John P. Hagen, director of NASA's Office of United Nations Space Conference.

• **First team recognition**—The annual Goddard Memorial Trophy is being awarded to an entire organization for the first time. Previous winners have been Wernher von Braun, S. K. Hoffman and K. J. Bossart.

The trophy is awarded each year for the outstanding accomplishment in the missile/space field during the previous year. Final selection was narrowed to two entries:

–Recovery of the first object from space with the successful retrieval of the *Discoverer XIII* capsule on Aug. 11, 1960.

–Achievement of operational status for *Polaris* with the sailing of the George Washington from Charleston, S.C., on Nov. 16, 1960.

With Lockheed Missiles and Space Division as prime contractor on both programs, the decision was made to award the trophy to LMSD for the teamwork and creative engineering which led to outstanding success in both.

• **Other awards**—Another presentation, to be made for the first time, will be the Nelson P. Jackson Memorial Aerospace Award, in memory of the president of the National Rocket Club, killed in an airplane crash last fall. Also to be presented are the Astronautics Engineer Achievement Award, the National Rocket Club Award and the Dr. Robert H. Goddard Memorial Scholarship Award.

The conference program includes panel discussions on military and civilian aspects of space flight and the missile/space market outlook. Those attending will be able to see the dedication of the Goddard Space Flight Center, a NASA installation in neighboring Greenbelt, Md., on March 16. A tour will be held March 17.

However, only 240 conference participants can be accommodated on the tour of the NASA Central Flight Control and Range Operations Laboratory, the Space Sciences and Applications Center and the Test and Evaluation Center. Reservations will be accepted on a first-come, first-served basis, the NRC said. ⌗

# Government Contracting Needs Overhaul

***AIA's Cook urges intense drive to cut rising costs; cites drop in earnings***

GOVERNMENT-INDUSTRY contractual relationships may have been outmoded by technological progress and "need reappraisal and re-evaluation," says Gen. Orval Cook, president of Aerospace Industries Association.

Speaking before the American Legion National Commander's Conference last week, Cook called for a stepped-up effort in developing new techniques and procedures to combat continually upward spiraling of costs.

He cited recent success of Air Force contractors in cost-cutting programs that had already saved millions of dollars. Such savings, he said, may be the final answer to whether we can or cannot design and produce the weapons we need for survival. "This (cost reduction) must be an immediate goal of industry and government."

• **In a single decade**—To illustrate the tremendous technological changes that are taking place, Cook drew a vivid picture of our present missile/space posture as compared with that of only ten years ago.

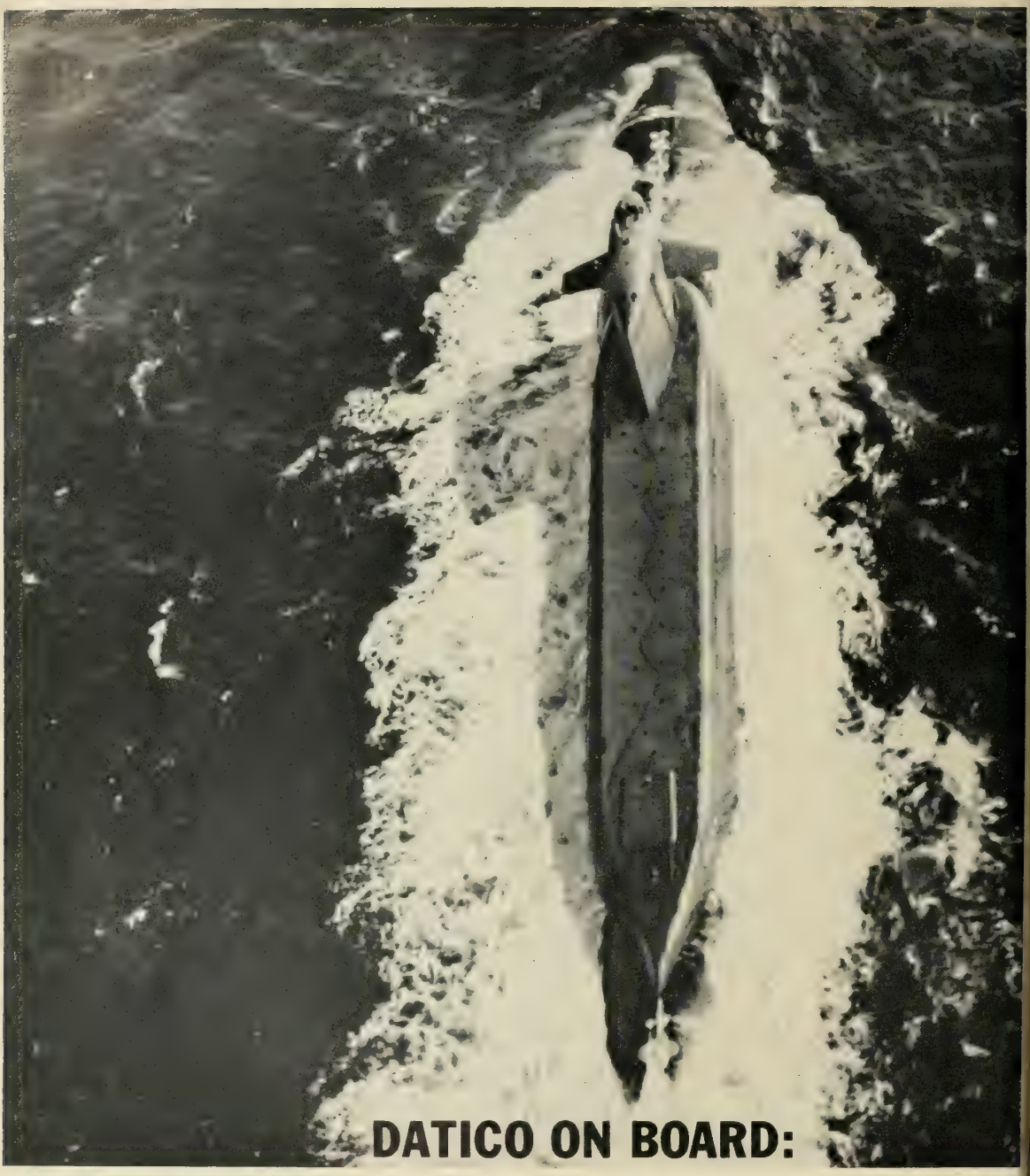
In 1950, we had not a single operational jet and the top speed of bombers was 300 miles an hour. The altitude record then was 47,000 feet.

Today, fighters operate at 1500 mph or more and surface-to-surface missiles reach speeds of 17,000 mph.

And the "aerospace" industry has changed nearly as radically, Cook said. In 1951, military aircraft orders totalled 92% of the backlog. Today, orders for missile/space vehicles make up more than 50% of the backlog and aircraft accounts for only about 30%.

Composition of the work force has also drastically changed in this decade. Nearly 200,000 more people are employed by the "aerospace" industry today, but only one-fifth of these are production workers. On the other hand, engineering employees—scientists, engineers, technicians—have increased to where, in one typical company, they make up one-third of the total employees.

Cook pointed out that the industry has had to invest over $1 billion in new facilities during the past five years. This, along with higher wages, inflation, and the impact of renegotiation and other Government fiscal practices, has severely limited the earning capacity of the "aerospace" industry. Present earnings are less than in 1950, even though sales are five times as great. ⌗



# DATICO ON BOARD:

# SIX MONTHS FROM CONTRACT TO COUNTDOWN

Just six months following contract award, Northrop began deliveries of Datico automatic checkout equipment for use in the Navy's Polaris Fleet Ballistic Missile program. Datico is used in factory, depot, tender, and submarine operations.

Datico is a digital automatic tape checkout system with a wide variety of applications. Its successful integration by Northrop into the Polaris and other major weapons systems demonstrates that the same basic Datico equipment can be used at all levels of maintenance and operation, utilizing the same test standards and methods and operated by personnel with the same basic training.

Northrop is at work on more advanced versions of Datico to extend its capability to an even wider range of military and industrial systems.

**NORTRONICS**
A DIVISION OF
**NORTHROP**



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# Technical Countdown

## ASTRONAUTICS

### No Lunar Orbit Try Before 1965

The next lunar orbit attempt will be in 1965, according to the present NASA schedule. It will be an outgrowth of Project *Surveyor,* aimed at soft-landing a *Centaur*-launched spacecraft on the lunar surface, beginning in 1963.

### Prospector to be Lunar Workhorse

The *Prospector* spacecraft, designed for roving about the moon's surface after making *Saturn*-boosted soft landings beginning in 1965-66, is expected to remain in service after manned lunar landings begin, now scheduled for 1971. Edwin M. Cortright, NASA chief of lunar and planetary programs, says *Prospector* can serve the lunar explorers for personnel transportation and to carry emergency supplies. Another version of *Prospector,* designed to return lunar samples to earth before men arrive, will be a "carrier pigeon" for the explorers to use in making return shipments.

### Solar Pressure Varies Echo Orbit

Solar pressure pushed the perigee of the *Echo I* balloon satellite down to 600 miles by Jan. 1, from its original altitude of 945 miles. Now that the earth is on the other side of the sun where it was at launching last Aug. 12, the sun is pushing the orbit back toward where it started. The cycle is expected to be repeated until atmospheric drag has shrunk the orbit to the point where the sun cannot push it back far enough. The satellite has at least another year of life, and probably more.

### Space Flights Timetabled by Computer

Lockheed is programing an IBM 7090 computer to figure timetables for space flights for years to come with use of low-thrust ion and plasma propulsion systems. Work is under Wright Air Development Division contract.

### Super Scout Launch in 1962

The first *Super Scout* will be *Scout 11,* the third operational vehicle, to be launched in mid-1962. The next *Scout*—No. 5—will be checked out at the Chance Vought plant under CV's new prime contract, eliminating time-consuming checkout at Wallops Island.

## ADVANCED MATERIALS

### Wrong Emphasis in Filament Winding?

Better binding resins for high-temperature applications in filament-wound case are being ignored in the search for superior fibers. Current Air Force feeling is that the resins, rather than other variables, will soon be the limiting factor. This is already becoming true in certain areas.

### Windows Make Problems

An effort is being made to bring airframe designers and glass manufacturers together on windshield problems in high-speed vehicles. The B-70 and *Dyna-Soar* applications cannot be met with current techniques—where the designer merely leaves a hole for the glazier to fill. Air Force presently has one jet aircraft in operation which requires glass replacement every ten flight-hours.

## PROPULSION

### Saturn Geyser Capped

One of the problems discovered during final series of *Saturn* static tests was that propellant coming through interconnecting pipes at the bottom of the tanks flared up in a fountain and wasn't picked up by the pumps. Problem was solved by putting a "hat" on the tank inlet.

### Neosho LOX Plant in Operation

Linde's new LOX plant at Neosho, Mo., adjacent to the Rocketdyne engine production plant, is now on stream. Capacity is 140 tons per day.

### New Second Stage Adds to Polaris Range

Most of the 300-mile range increase of *Polaris A-2* is credited to the new Hercules second-stage motor with its lighter Spiralloy case and higher $I_{sp}$ propellant. The case is constructed of nearly 268 thousand miles of continuous glass filament—enough to reach from earth to the moon.

## SUPPORT EQUIPMENT

### Gearless Drive for Advent Shipborne Antennas

Navy has specified gearless power drives for 3-axis tracking antennas to be used on shipborne terminal for *Advent* communications satellite system. General Electric Ordnance Dept.—which developed the gearless drive for *Tartar* fire control radar—has been awarded the contract.

### Radio Telescope to Use Servo-Optical Alinement

The Navy has decided to use a servo-optical system to aline the NRL 600-ft. Sugar Grove radio telescope. Both optical and inertial systems were originally considered. Contract for the system is expected to be let soon.

### No. 4 Saturn to Use Second Complex

Launch Complex 37 at Cape Canaveral, the second *Saturn* complex, is to be used beginning with the fourth *Saturn,* currently scheduled for launch in early 1963. This second facility has been funded, but construction has not yet started.

## ELECTRONICS

### World's Fastest Germanium Switching Transistor

Sylvania has produced a new germanium epitaxial mesa transistor with a maximum switching time of only 110 nanoseconds ($10^{-9}$ seconds)—over twice as fast as conventional switching transistors. New device combines the advantages of both epitaxial and mesa construction.

### Transistor Sales Set Record

1960 transistor sales zoomed to a total of nearly 128 million units—a better than 50% increase over the previous year—according to Electronic Industries Association figures. Dollar value was over $301 million.

### Arma Leads Guidance Producers

Based on recent industry reports to M/R, the 1960 production market for missile/space inertial-guidance systems was led by American Bosch Arma (22%), followed by AC Spark Plug (19%), Autonetics (12%), Sperry Rand (10%), and General Electric (9%). Honeywell, Bendix, Nortronics, Kearfott, and Summers Gyroscope controlled about 5-6% each. By 1962, however, leaders are expected to be Autonetics, Bendix, GE, Honeywell, and Summers—in that order.

# Endless Recycling Of Water & Oxygen

***System weighing 200 lbs. could sustain space flyer indefinitely; GE gets additional contract***

by Heather M. David

PHILADELPHIA—Astronauts on long-term voyages may get all their water and oxygen supply from a new life support system weighing as little as 200 pounds.

The system, under development at the General Electric Space Sciences Laboratory here, requires only one day's supply of oxygen and water which is recycled endlessly from man's metabolic wastes. As a yardstick, the Project *Mercury* oxygen and water supply and air purification system—which uses stored materials—weighs almost 90 pounds.

• **First in use**—One part of the system, the water recycling unit, will go into operation at the Naval Air Materiel Center within the next four or five months. It will be used in bioastronautics research and in duplicating mission profiles at the Air Crew Equipment laboratory. Facilities of this laboratory are used by all the armed services and NASA.

Under an $18,000 Navy contract just awarded GE, the unit will provide potable water for six men for periods of eight to fourteen days from their recycled digestive wastes.

The GE Space Sciences group, headed by Biotechnology manager Jack J. Konikoff, has been researching closed systems since late 1958. Part of the work on the urine recycling system has been supported by a two year $94,000 NASA contract awarded last February.

Last fall, the director of the Naval Air Crew Equipment Laboratory, Capt. Roland A. Bosee, was the subject of a six day test of the system. For the thousandth time, Jack Konikoff says, "Yes, he's still alive."

As a matter of fact, very extensive blood analysis, including red and white cell count, and other physical data bore out the fact that there are no ill effects from the reuse of water.

In addition to the successful tests on man, a colony of rats has been maintained on recycled metabolic wastes for three generations. There has been no evidence of toxic buildup or genetic effect.

Visitors to the Space Sciences Laboratory are invited to take a taste comparison test. They're offered three glasses of water, asked to pick the one which tastes worst. The glasses contain distilled water, recycled water and "Brand X." Almost invariably picked as the only one with a foul taste, Brand X is revealed to be Philadelphia water.

Microscopic and chemical studies of the reprocessed water support this. Water recovered in the General Electric system has been carefully measured by U.S. Public Health Service Drinking Water Standards, and adjudged potable. It scores well against impurities counts of ordinary tap water and is as free from taste or odor as distilled water.

• **Two-step process**—The process by which water is recycled is relatively simple. The waste material is collected in a still pot and heated in a vacuum of about 60 mm Hg, or 1.16 psi. At this low pressure, it will vaporize at temperatures of about 90°F. Non-volatile materials are left behind.

However, vacuum distillation alone will not purify the water. Ammonia and other volatile materials still remain.

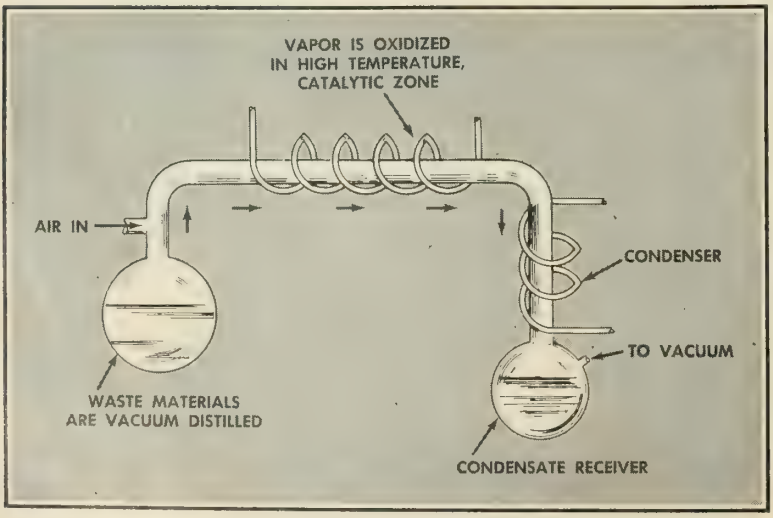
Konikoff's group has found that by oxidizing the vapor in the presence of a catalyst, these materials can be destroyed. Thus the vapor is passed through a high temperature zone in which a minute amount of platinum gauze is contained. This gauze is not contaminated by the reaction and apparently can be used indefinitely.

The vapor is then condensed and ready to be used for drinking purposes.

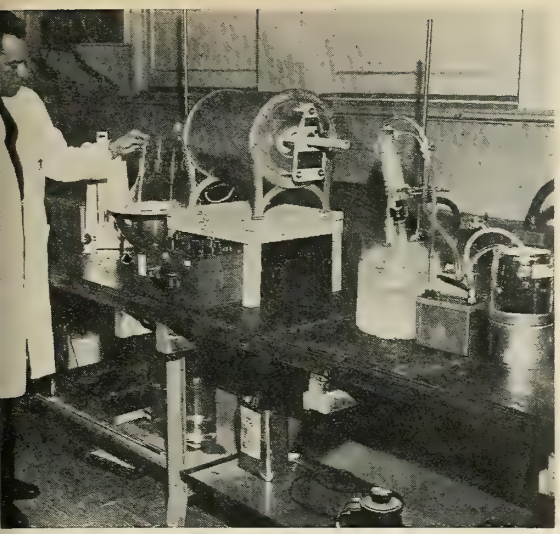
One modification will have to be made in the system to adapt it for weightlessness. Konikoff sees several solutions: the liquid may be held by sponge material, or a microscopic filter could be used to separate the liquid from the vapor. The liquid molecules, being larger than those of the vapor, would be held under the filter.

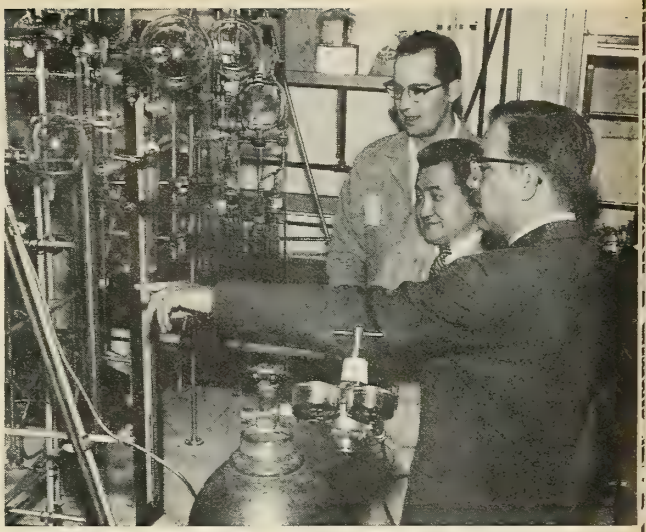
Use of the system in space will bring benefits, too. The space vacuum is available for the vacuum distillation process. It also is feasible that a solar furnace could be constructed to center on the catalyst in the high temperature zone. This would cut the unit weight to as low as 30 pounds. The zone itself requires temperatures to 950°F.

No extra air needs to be pumped into the system but that normally cir-




*SCHEMATIC FLOW DIAGRAM of General Electric's water recovery technique.*





*LABORATORY TESTS have proven concept. Left: Capt. R. A. Bosee checks water recycling unit of type GE will develop for Naval Air Crew Equipment Lab. Right: $CO_2$ decomposition studied by J. J. Konikoff, A. H. Okamoto, V. Cordua.*

culating in the cabin. Apparently only minute amounts of air are required for oxidation to take place, a blessing since the greater the air requirement, the higher the heat input.

Germs and viruses probably would not survive after exposure to the high temperatures. Laboratory samples showed almost negative amounts of bacteria and strep organisms, even though the equipment itself had not been sterilized. City water suffered by comparison.

A normal, active man consumes about five pounds of water a day. He expends about one-half of this digestively, the other through respiration and perspiration.

Water given off in respiration and perspiration can be retrieved from the cabin air in several ways. The GE group says the best seems to be by collection by lithium chloride desiccant, which is heated to about 300°F and the water driven off. The material is reusable.

The water also can be collected by dew-point condensation or freezing. These methods may have advantages since a closed cabin will require some type of heat exchanger to run a cooling system to cool the cabin atmosphere. The air moisture could condense upon the exchanger, or if the wall temperature were low enough, freeze there. This water could be collected and made available for drinking.

The second major system in the General Electric concept is the recycling of oxygen from carbon dioxide.

• **Removal of $CO_2$**—In the Project *Mercury* system, lithium hydroxide is used to remove carbon dioxide from the air. For short voyages, this material is very efficient since it will absorb almost its own weight in carbon. However, for a longer voyage, this material is impractical since it is very difficult to make it reusable.

The Advanced Engineering Group in MSVD's Life Support Operations, responsible for life support hardware and engineering, have worked out a "molecular sieve" to collect carbon dioxide. Although not as efficient in a weight-work ratio as lithium hydroxide, it can be reused after a simple regeneration process.

According to Norman Belasco, senior project engineer, the material used is a synthetic zeolite crystalline structure. The tiny white crystals are contained in cartridge form, probably two of which would be carried on a trip.

A molecular sieve is a sieve in the sense that it has minute orifices through which only molecules of a certain size can pass. The zeolite was chosen to select the carbon dioxide from the circulating air and hold it in the cavities of the crystal framework.

When one cartridge becomes "saturated," it is cut off and exposed to a vacuum at 212°F. The $CO_2$ is removed, caught and collected for the oxygen recovery system. The presence of the space vacuum will cut down the regenerating time to minutes, but for laboratory purposes the cartridge is reusable in about a half-hour.

• **Oxygen recycling**—The General Electric group utilizes a physico-chemical reaction to recover oxygen from the carbon dioxide. The technique is called the Fischer-Tropsch Synthesis.

All the oxygen is removed from

## TABLE I

Equipment weight per man for several ecological systems

| TYPE SYSTEM | STORED SUPPLIES | FIXED APPARATUS WEIGHT* | WEIGHT FOR ONE DAY | WEIGHT FOR 30 DAYS |
|---|---|---|---|---|
| Open system, all stored supplies | 16 lbs. | 5 lbs. | 21 lbs. | 485 lbs. (will multiply by number in crew) |
| Partially closed system: water in air is regenerated | 12 | 22 | 34 | 382 (will multiply by number in crew) |
| Partially closed systems: Both water and carbon dioxide in air regenerated | 9 | 37 | 46 | 307 (increases with each succeeding crew member) |
| GE closed system | 1 (food) | 199 | 200 | 229 (increases but does not multiply with each succeeding crew member) |

* Includes 5 lbs. activated charcoal which removes odors and air contaminants

## TABLE II

Weight and Energy Requirements for General Electric Closed System

| SUBSYSTEM | ENERGY REQUIREMENT PER DAY—BTU | APPROX. WEIGHT OF APPARATUS |
|---|---|---|
| Water retrieval from urine | 7000 | 30.00 lbs. |
| Water retrieval from air (LiCl adsorbed) | 5270 | 9.28 |
| $CO_2$ removal from air (molecular sieve) | 2190 | 10.00 |
| Oxygen retrieval from $CO_2$ | | |
| Water from $CO_2$ | —3280 (exothermic) | 45.00 |
| Oxygen from water | 18,400 | 5.00 |
| Energy supply—fuel cells, weight and storage | | 100.00 |
| TOTALS | 29.580 Btu (approx. 9 Kwh) | 199.28 lbs. |

the carbon dioxide and converted into water by this reaction:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

Optimum temperature for the reaction seems to be between 750°F to 875°F, Konikoff said.

As the equation shows, methane is formed as a biproduct. There is a possibility this could be utilized as a fuel, or as a basic starting material for a wide variety of chemical syntheses.

The Space Sciences group is working on the idea that the methane could be decomposed into carbon and hydrogen. Theoretically, the carbon can be activated and used for odor control. But this process will not be simple.

Oxygen is recovered by electrolysis from the water formed by the reaction. The hydrogen also given off is recycled through the reaction chamber to participate in the initial reaction for the next batch. General Electric has developed a special fuel cell supporting this entire process which weighs only five pounds.

The only other element needed in the life support system is food. Konikoff said there is no immediate need for working out an algae recycling system as has often been suggested. Not only is the stuff pretty unpalatable but the present state of the art in packaging and dehydrating conventional foods makes it possible to carry a year's supply weighing less than 400 lbs.

• **Future projects**—General Electric's Space Sciences Laboratory also is engaged in algae research. Although algae are an effective source of oxygen, they require such optimum growing conditions (light) and are needed in such quantity that they are generally considered impractical for space trips in the near future. Konikoff's group is searching for other practical uses of the plants.

Possibilities they are considering include the side use of algae as a radiation shield, and as a source of chemicals which could be converted into fuels and other useful compounds. ⌗

# NASA Maps Post-Mercury Manned Shots

### *Two or three years between close of Mercury and start of Apollo are planned for*

SPACE FLIGHT with men and animals after the end of the presently approved Project *Mercury* launching is up for decision in the near future.

The National Aeronautics and Space Administration has contracts with McDonnell Aircraft Corp. for the delivery of 24 *Mercury* capsules, of which six have been flown and the remainder are to be flown by the end of 1962 or early 1963.

The schedule for Project *Apollo*, the follow-on program aimed at launching three-man capsules aboard *Saturn* vehicles, is still uncertain. But it is clear that manned *Apollo* flights could not begin before *Saturn* is man-rated, probably in 1965 or 1966. Thus there is a period of two or three years between the end of the present program of manned *Mercury* flights, and the deginning of manned *Apollo* flights.

Plans under consideration include orbital flights with animals and then men in capsules something like the *Mercury* capsule for periods ranging from 2 to 14 days. Clark T. Randt, director of NASA's Office of Life Science Programs, told the Senate Space Committee recently of plans to investigate the ability of living organisms to cope with the space environment in five areas. He listed them as:

–Effect of weightlessness on the performance of men and animals.

–Measurement of the electrical phenomena associated with brain activity.

–Observation of the reaction of the heart and circulatory systems.

–Physical science experiments in radiation and micrometeorite impact.

Randt said the current *Mercury* program and related experiments will fill the need for the required data for periods up to several hours. The next phase of investigation, he said, is to obtain similar information for periods of two days to two weeks.

Other NASA sources indicated that it is not clear whether an *Atlas* booster is capable of putting a *Mercury* capsule into stable orbit lasting longer than the 4½-hour period planned for the first phase of *Mercury* flights. The first capsule orbital flights are expected to provide such data.

If *Atlas* alone cannot do the job, NASA might consider man-rating the *Agena* or *Centaur* stages for follow-on manned experiments, one source said.

The present *Mercury* program calls for launching 18 more capsules. One will be aboard a *Little Joe* and five will be in the *Mercury Redstone* program. Unless there are switches made necessary by repeating *Little Joe* or *Redstone* flights, the remaining 12 would be *Atlas* capsules. Thus, if manned orbital flights begin with *Mercury Atlas 8* or sooner, each of the seven astronauts might have the opportunity for one orbital flight. ⌗

## RCA Building Advanced Vehicle Testing Center

A MULTIMILLION-DOLLAR advanced space vehicle test center will be put into operation at Princeton, N.J., by the Radio Corporation of America.

The installation, adjoining present engineering laboratories of the RCA Space Center, will center about an eight-story-high structure housing a vacuum chamber for complete satellites and space vehicles.

In addition to a vacuum comparable to that existing several hundred miles above the earth, the chamber will have a temperature range from –100° to 250°F. The system will maintain these conditions for up to three months. ⌗




# assignment: make a complex missile system work

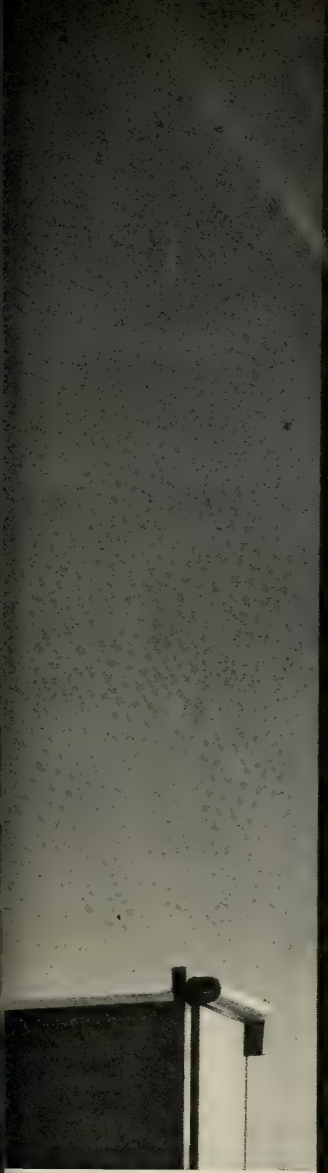
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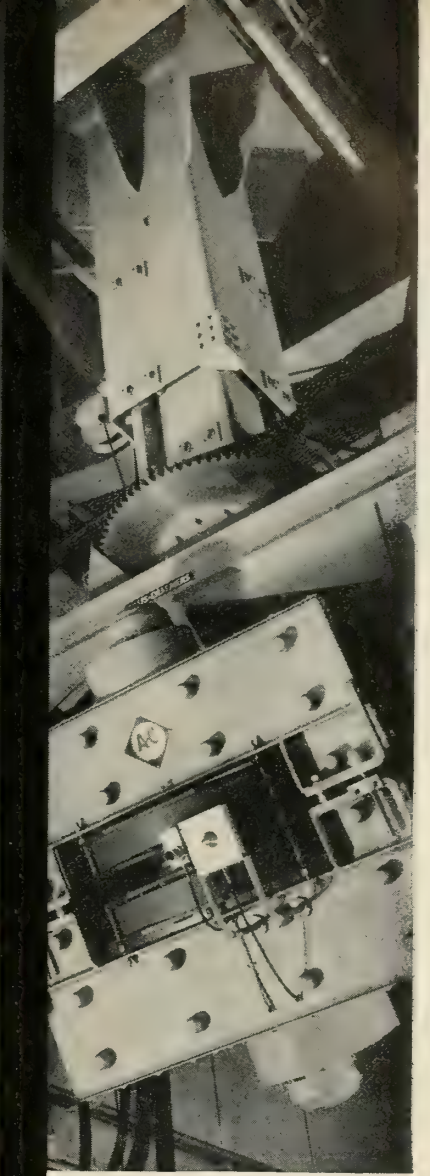
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SCIENTISTS AND ENGINEERS: JOIN THIS TEAM


SPACE . . . IMAGINATION . . . ENERGY



Within these labyrinthed entrances, shielded from the world by six feet of reinforced concrete and full-height earth barricades, lurks the mighty Betatron. Its task: to search out any defect in production-line propellant grains exposed to its powerful X-ray eye.



This giant eye is only one part of our complete nondestructive test installation at Bacchus. Through such steps, the life history of each individual unit becomes an open book—its reliability can be computed, its readiness known before the need arises. Such exacting tests pave the way to space.

# Here twenty-five million electron volts probe the inmost secrets of a missile

Vastly more powerful than any known industrial X-ray apparatus, the Betatron yields a clear picture through the full girth of the third-stage Minuteman engine in an eight-minute exposure, contrasted with more than a nine-hour exposure required with 1,000 curies of cobalt 60. Resolution is such that irregularities down to 0.01 inch can be examined. Power of the instrument, and dimensioning of the building which houses it, are more than equal to the task of scrutinizing interior topography of the cast composite double-base solid-propellant motors made at Bacchus: the third-stage Minuteman, advanced second-stage Polaris, Altair, and the others.

XP61-1





*Chemical Propulsion Division*

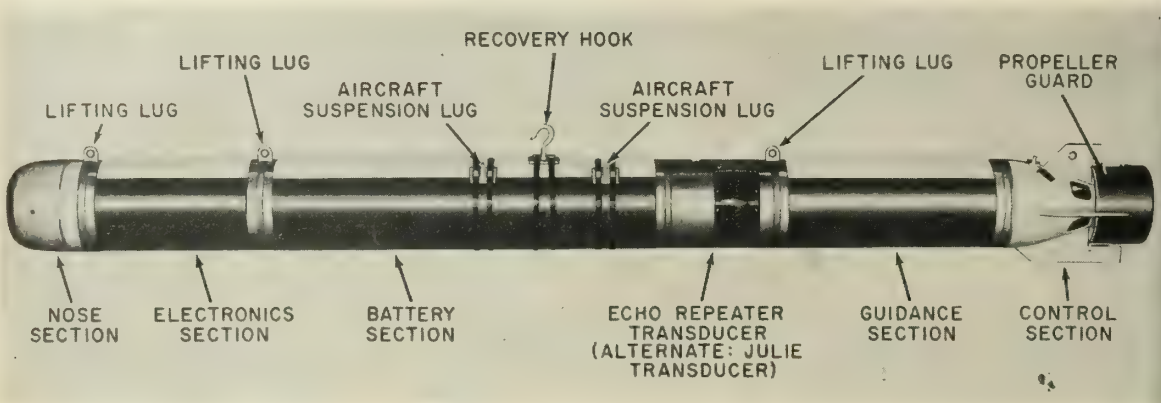
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# Navy Getting Sub Target Simulators




*SUBMARINE SIMULATOR for training ASW crews in art of detecting, localizing, classifying and killing underseas craft.*

**by William Beller**

SMALL TORPEDO-LIKE devices able to maneuver and sound like submarines will soon be exercising the Navy's antisubmarine warfare teams. First production units of these submarine target simulators are being delivered to the fleet this month.

This means that the Navy can start putting back into line duty some of the submarines it has been using as practice targets. It also means that the service can train ASW technicians such as sonar operators under realistic conditions but without the high operating costs of a submarine.

The simulators going into operation are the first to be self-propelled and able to analog all the functions of a submarine. They can maneuver evasively, give out submarine running noises such as propeller beat and machinery operation, and echo sonar pulses.

The target simulator can be launched and recovered from surface ships and helicopters. With a modification, it can be launched out of a submarine's torpedo tube.

When submarines are in short supply for training ASW teams, or when the instruction is for technicians and elementary, then land-based simulators or sea-based echo-repeater targets are often used. However, because these devices are several degrees away from those used under real-life situations, they are not entirely satisfactory. For this reason, the U.S. Navy Training Device Center contracted with the Clevite Ordnance Div. of Clevite Corp. to develop and build the ASW target now in production.

• **How it works**—Clevite made the target simulator on the modular principle. This makes it possible to change one or more of the device's functions by simply replacing one subassembly with another. Thus, the simulator can be turned into an ASW countermeasure or fitted with a homing head or transformed into a torpedo target.

The simulator is able to perform typical submarine maneuvers for two hours. Under special conditions, this period can be extended to six hours. The vehicle will cruise at 8 knots and can show bursts of speed up to 10 knots.

Its primary power comes from a rechargeable battery. This drives a fractional horsepower motor which turns a set of contra-rotating propellers. The target is steered by elevators and rudders which are solenoid-controlled.

When the simulator passes through a sonar beam, it receives, amplifies and retransmits the sonar pulses exactly the way an actual submarine would. At the same time, the target generates and transmits the noise characteristics of a running submarine.

After its run is finished, the target surfaces and aids in its recovery by ejecting dye from a 1.5-quart reservoir. Also, its echo-repeater sends out a signal to permit location by sonar.

• **Putting in the performance**—The simulator target contains a programmer for prescribing in-water operations. It controls propulsion and guidance. A moving 35mm film tape passes between a rotary platen and five contact fingers. Slots punched in the tape permit or

## Characteristics of ASW Submarine Target

| | |
|---|---|
| **Length** | **132 in.** |
| **Diameter** | |
| **Body** | **10 in.** |
| **Across Stabilizing Fins** | **13⅝ in.** |
| **Weight** | **344 lbs.** |
| **Buoyancy** | |
| **Salt Water** | **13 lbs. positive** |
| **Fresh Water** | **3 lbs. positive** |
| **Primary Power Supply** | **Battery** |
| **Speed** | **8 knots** |
| **Running Time** | **2 hr. max.** |
| **Arming Time** | **30 sec. min.** |
| **Depth** | |
| **Up Limit (Adjustable)** | **50 ft. min.** |
| **Down Limit (Adjustable)** | **200 ft. max.** |
| **Initial Operating Depth** | **Equal to either up or down limit** |
| **Rate of Depth Change** | **4.6 ft. per sec.** |
| **Initial Course Preset** | **Either Port or Starboard, 0° –180°** |
| **Azimuth Turning Rate** | **5° per sec.** |
| **Sonic Simulator** | |
| **Range** | **5000 yd.** |
| **Frequency** | **100 cycles to 10 kc. per sec.** |
| **Echo Repeater** | |
| **Frequency** | **8-30 kc. per sec.** |
| **Julie** | |
| **Frequency** | **3-7 kc. per sec.** |
| **Sonic End-of-Run Indicator** | |
| **Frequency** | **8, 10, 12 or 14 kc. per sec.** |
| **Dye Capacity** | **1.5 qt.** |

or more contact fingers to become grounded for a short period.

The grounding of a contact finger actuates a corresponding relay to operate one of five functions: speed change, port turn, starboard turn, shallow stratum and deep stratum. At the end of a run, the programer actuates a relay to bring the target to the surface.

Slots may be punched in the programer tape to send the target on maneuvers that might be used by a submarine trying to evade detection. The slots may provide for a straight run or a circular course, or for numerous changes in depth or azimuth during the course of a run.

Two standard tapes are used, one pre-cut for echo-repeater operation and the other for Julie-type operation. Other type tapes can also be cut and used.

The echo repeater is a passive device which functions upon receiving a pulse from a sonar transmitter. The pulse is amplified and retransmitted back to the sonar receiver with enough power to simulate the echo to be expected from a real submarine.

The Julie system is also a passive device, which functions upon receiving the noise signals created by an underwater explosion. The noise is amplified and transmitted to provide echoes to a sonobuoy receiver. In turn, the sonobuoy receiver transmits the noise by a radio link to either ship or aircraft.

The target's sonic simulator continuously generates noise characteristic of submarine cavitation and screwbeat. There is reasonable matching of these characteristic noises to those produced by submarines traveling 6 to 12 knots. Search ships having sonar equipment operating in the frequency band of 100 cycles to 10 kc. can track these noises up to nearly three miles range.

Because of the economies that can come from using submarine simulator targets instead of submarines for training ASW teams, many of the NATO countries are showing high interest in the scheme. In addition, the Royal Canadian Navy has been directly participating with the U.S. Navy in the recent evaluation tests of the Clevite-designed vehicle. ⌘

# Clevite's Rugged 'Oyster' Gives Consistent Performance

PRODUCTION QUANTITIES of a new general-purpose underwater transducer are showing unusually consistent response curves. This is of high interest to the sonobuoy industry which often has to cull quantities of production transducers to find those in a given performance bracket.

The device, which came on the market recently, is rugged enough to be planted by aircraft, cheap enough to be highly expendable, and resistant enough to withstand deep salt-water immersion for one week.

Designated the "Clevite Oyster," it is manufactured by the Clevite Ordnance Div. of Clevite Corp. In production quantities, each transducer is sold for about six dollars.

• **Design and performance**—The usual transducer has a sensitivity range—the ratio of output voltage to applied voltage—of over 10 db. The Oyster is reported to have a sensitivity range of only 2 db. Hence, special circuitry does not have to be included in a sonobuoy to make up for variations in the transducer's performance.

A line array of Oysters dropped from aircraft can have their sensitivities arranged so that signatures of different types of underseas craft can be recognized.

The Oyster design comprises two stiff circular pistons which drive a pile-up of hollow discs of piezoelectric material. As these discs are compressed, they produce sound waves. The simple, straightforward and axial, design makes the device strong and relatively insensitive to shock, vibration and heat.



*PRODUCTION version of the Clevite Oyster for use in sub detecting.*

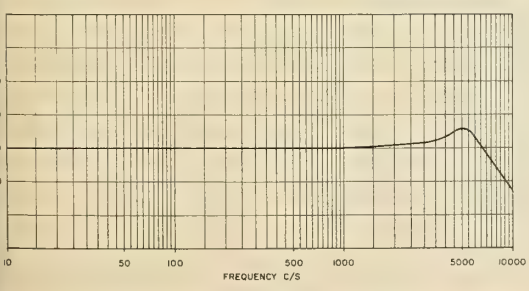
The piezoelectric material, a ceramic, is prestressed in compression. This prestress plus that put in during operations by water pressure gives the material no chance to take on a tensile load, which would shorten its operating life.

Over its normal frequency range, the transducer is substantially nondirectional. In the medium and low frequency ranges, it can be used as a low power transmitter, with an efficiency at resonance of about 15%.

The Oyster has survived the following environmental tests: shock, 150g; thermal shock, 150°F to 40°F; storage temperature, 160°F to −60°F; salt-water immersion, one week; test pressure, 60 psi; and sunshine, 100 watts/sq. ft. for 60 hours. ⌘

## Specifications

**Diameter: 2 in., Thickness: ½ in.**
**Weight, without cable:**
**Brass pistons 3.7 oz.**
**Aluminum pistons 1.6 oz.**
**Operating frequency: 10-10,000 cps.**
**First hydrophone resonance: 5 kc.**
**Capacitance: 2900 picofarads.**
**Output voltage below resonance:**
**—90 db., ref 1 v. per microbar (into 60 ft. of cable).**
**Dynamic range in excess of 100 db.**
**Transmitting efficiency (resonance): 15%**




*YPICAL RESPONSE curve for Oyster at end of 60-ft. cable.*

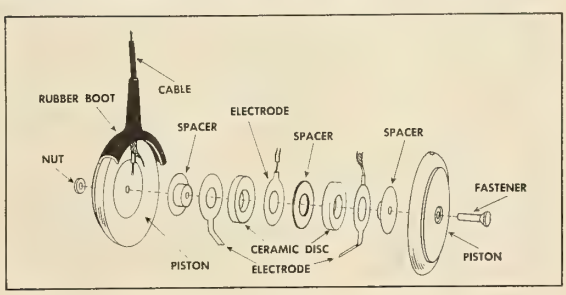
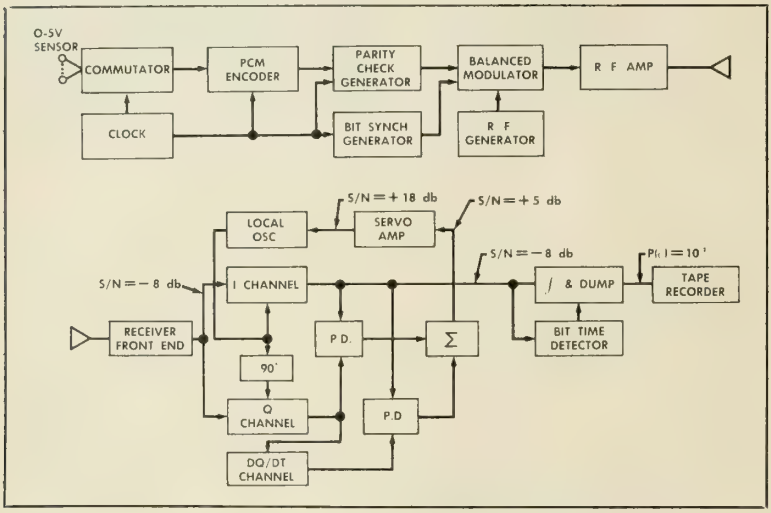


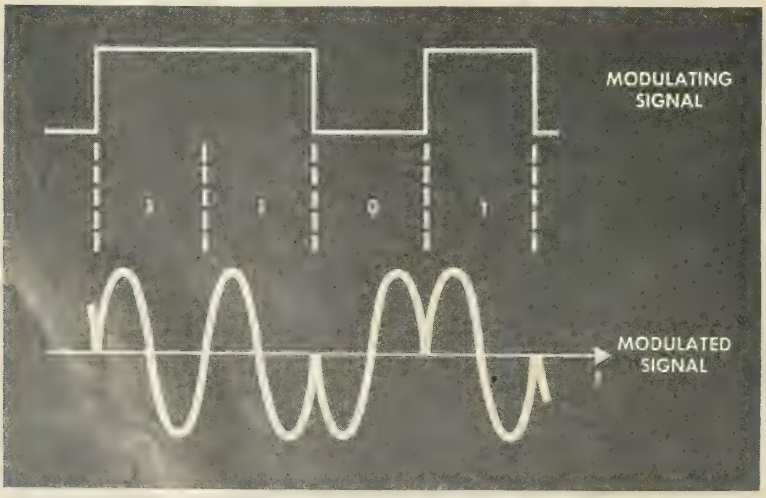

*DIAGRAM of underwater piezoelectric transducer.*

# GE's 'Synchrolink' Swells Telemetry Range

***Makers claim PCM-PS system will send signals three times farther with same power as present systems***




*PCM-PS BLOCK DIAGRAM. Product detectors (P.D.) following standard receiver front end avoid penalty of picking up r-f detection threshold at low S/N levels.*




*CONTINUOUS LEVEL of r-f energy is transmitted with PCM-PS system. "O" signal is 180° out of phase with that of "1."*

AN EXPERIMENTAL version of a new digital telemetering system with tremendously increased range capability has been built by General Electric Missile and Space Vehicle Department.

GE says the new "Synchrolink" PCM-PS (for pulse code modulation, phase-shift) system can transmit signals three times as far as any equipment yet flown, or transmits data over the same distances with only about one-tenth the power requirement of present systems.

The increase in range capability is based on "inherent efficiencies" of the Synchrolink system which make it, according to Dr. Stanley Hurst, GE scientist, "the most efficient practically realizable with today's technical know-how."

Efficiency gains are based primarily on the use of correlation detection and a novel redundancy coding method. Use of a threshold-free synchronous receiver permits r-f detection of signals at extremely low signal-to-noise ratios (less than −8 db).

Other advantages claimed for the Synchrolink system:

–Existing ground equipment requires only minor modification to receive Synchrolink signals.

–Transistors are used as switches—their most reliable mode.

–The system is flexible, allowing for alterations of channels and combinations of channels, even in flight, to accommodate measurement changes.

–Digital techniques are inherently of high accuracy. Data may be repeatedly converted, transmitted, or stored for long periods with no loss in accuracy.

The PCM-PS system employs double sideband suppressed carrier modulation of the r-f carrier. Equal amounts of r-f energy are transmitted at all times with the "O" signal 180° out of phase with that of the "1".

Compared with other systems, the PCM-PS requires a transmitter power equal to or less than that of an ideal PCM-FM system. In practical missile/space applications, limitations due to r-f detection threshold and doppler shift problems further reduce the efficiency of PCM-FM (and PCM-PM) below theoretical values.

• **Power compensation**—The average power required for PCM-PS is half that for the PCM-AM system.

Power efficiency of a PPM-AM system is better than that of PCM-PS. However, this efficiency is obtained at the expense of much greater bandwidth. At identical S/N ratios and bandwidth—and assuming use of an efficient redundant code for PCM—all PCM systems can perform better than PPM-AM.

The airborne portion of the PCM-PS telemetry system consists of a com-

| System | Relative Power Efficiency | |
|---|---|---|
| | S/N Out = 44 db | S/N Out = 32 db |
| PPM—AM | 1 | 1 |
| PCM—PS | 1.75 | 1.25 |
| PCM—FM | 1.75 | 1.25 |
| PCM—PM | 2.2 | 1.6 |
| PCM—AM | 3.5 | 2.5 |

mutator, PCM encoder (analog-digital converter), parity encoder and r-f section with a balanced modulator for PS modulation. Frame synchronization is maintained by transmitting a unique code at the beginning of each frame. Bit synchronization uses a signal added to the PCM pulses at about 1% of full radiated power.

The receiver has a standard front end, followed by a pair of product detectors and the acquisition and tracking loops for the reinserted carrier frequency. The dipolar pulses with fluctuation noise are processed in the integrate-and-dump decoder. Beginning and end of a bit period are derived from the bit synchronization signal and are used to start and stop the integration process.

The output pulses of the integrate-and-dump equipment are free of noise but have a definite error rate. Error correction through the use of the parity information will be done during the data processing, either in the digital computer, or in an auxiliary equipment. ⌗

## Top Panel Prepares Weapons Testing Data

DR. J. B. FISK, president of Bell Telephone Laboratories, is head of a panel to study, review and bring up to date for the new administration the technical considerations bearing on ending weapons tests.

The panel will make data ready for the resumption of negotiations with the Soviet Union at Geneva, now scheduled for March 21. Other members of the Fisk panel are:

Dr. Hans A. Bethe, Cornell University; Gen. Austin W. Betts, Atomic Energy Commission; Dr. Harold Brown, Lawrence Radiation Laboratory; Spurgeon M. Keeny, Jr., White House Science Adviser's Office; Dr. Richard Latter, Rand Corp.; Gen. Herbert B. Loper, Office of Secretary of Defense; Dr. J. Carson Mark, Los Alamos Scientific Laboratories; Doyle Northrup, Air Force Technical Application Center; Dr. Wolfgang K. H. Panofsky, Stanford University; Dr. Frank Press, Cal Tech; Gen. Alfred D. Starbird, AEC; Dr. Herbert F. York, DOD. ⌗





# INERTIAL QUALITY

## SINGLE AND 2 AXIS ACCELEROMETERS

Highly precise and accurate, Kearfott's accelerometers are pendulous devices which sense airframe acceleration forces acting on them.

A pendulum utilizing a unique Hooke's joint suspension displaces as a function of acceleration. An AC pickoff signal is rectified and applied to voice coils restoring the pendulum to null. The DC required for restoration is proportional to acceleration. Typical characteristics for these units include range of ±25 g's, scale factor of 5.0 ma/g, linearity of ±0.005% and threshold of 2 x $10^{-7}$ g's.

CHARACTERISTICS:

| TYPE NO. | SINGLE AXIS F2401 | SINGLE AXIS 429037 | TWO AXIS 326778-1 |
|---|---|---|---|
| Range of Measurement | ±20g | ±25g | See above |
| Scale Factor (output) | 5.0000 ma/g | 5.0000 ma/g | |
| Operating Temperature | 155°F ±5°F* | 50°F and +160°F | |
| Threshold | 5 x $10^{-7}$g | Less than 2 x $10^{-7}$g | |
| Zero Stability | ±0.05 milliradian | ±.00005g day to day | |
| Vibration | Up to ±10g peak from 20 to 2000 cps | Up to ±5g peak from 20 to 2000 cps | |
| Storage Temp. | —65°F to +200°F | —60°F to +170°F | |
| Scale Factor Variation | ±.01% randomness | ±0.01% randomness | |
| Excitation | 6 volts, 3860 cps** | 6 volts, 4000 cps** | 3.4 volts, 4000 cps*** |
| Natural Freq. | 180 cps | 210 cps | 160 cps |
| Freq. Resp. | Flat to 250 cps | Flat to 160 cps | Flat to 100 cps |
| Shock | 60 g's | 30 g's | 30 g's |
| Weight | 4 oz. | 7 oz. | 2 lbs. |

*Available for 180°F.
**Carrier frequency to 100 Kc may be used.
***When tested with Kearfott A3501-01 amplifier.

*Write for complete data*

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# Lasers for Intergalaxial Contact?

by Charles D. LaFond

***Highlights of OSA spring meeting—important strides in research, vast promise in communications***

PITTSBURGH—Contact with intelligent beings in other galaceis (galaxies)—if they exist—could result from use of super-range communications soon to be feasible with advanced laser techniques.

Such a possibility was advanced here during the recent Optical Society of America's Spring Meeting, at which a bumper crop of laser (Light Amplification by Simulated Emission of Radiation) papers were presented.

Twenty-three scientific papers were presented on laser developments of every type and variety before record audiences at the Pick-Roosevelt and Penn-Sheraton Hotels here. The predicted 700-person registration of the nations top optical scientists and engineers was further enlarged by an overflow from the nearly 4,000 attendees of the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, meeting concurrently.

A highpoint in the meeting was reached with the first symposium—at a joint session—by Dr. Charles H. Townes of the Institute for Defense Analyses, Washington, D.C.

Through the use of laser techniques for intergalaxial communications the first answer to the existence of other civilizations may be found, Townes asserted.

It is within the realm of possibility, he said, that highly intelligent beings exist in other worlds—and may have been trying to communicate with us for hundreds of years.

A good astronomical observatory using the new laser techniques could pick up possible beams of light transmitted from outer space and study them spectrographically.

Four years of travel time in each direction would be required for communication with the nearest star, Alpha Centauri, the former Columbia University professor said, but recognition of such returned light signals would not be difficult.

• **Plasmas investigated**—Spectroscopic measurement of energetic arc plasmas was described by Dr. P. M. Griffin of Oak Ridge National Laboratory, Oak Ridge, Tenn. The laboratory, operated by Union Carbide Corp. for the Atomic Energy Commission, is using spectroscopic methods to evaluate electronic and ionic "temperatures" (mean kinetic energies) of particles in plasmas. Griffin said arc plasmas have been studied, having temperatures ranging from 40,000°F to 1.5 million °F.

A Luce carbon arc (named after its developer, John S. Luce of ORNL) is currently under study which employs a low-pressure, high-current arc between electrodes located in a very strong magnetic field.

Electron temperatures in this system range from 40-100 thousand °F. However, he said, studies of ionic-species Doppler motion indicate positive ion temperatures of from 0.2-1.5 million °F.

In describing the action of these whirling, magnetically confined plasmas, Griffin said they exhibit a tornado-like rotational motion by the ions about the arc axis. Particle velocities, however, exceed that of a typical tornado by roughly 100 times.

Results of this continuing research should provide a better fundamental understanding of plasmas of thermonuclear origin, Griffin said. The temperature differences already revealed between ions and electrons collision may not be as significant as believed previously.

Also, the vortex-like motion could be an important ingredient for sustaining a fusion reaction.

• **Re-entry simulations**—Laboratory simulations to study re-entry problems with high-velocity objects are being performed with extremely sophisticated optical systems, according to a report presented by Dr. I. D. Liu. The Canadian Armament Research and Development Establishment has used such a facility to obtain a high degree of environmental control.

To simulate re-entry, scientists have used a range consisting of a steel tank of from 6 to 10 feet in diameter and several hundred feet long. The tank can be evacuated to simulate any altitude.

Through the tank, scaled models of the test subjects are fired from a hypervelocity cannon at speeds up to 15,000 mph. Since objects traveling at this speed will pass a given observation point in a few microseconds, a streak spectrograph is used, said Liu, to study the light emission produced by interaction of the object and the surrounding atmosphere.

Temperatures of the order of 24,000°K are reached in the shock envelope, with resulting molecular dissociation and ionization. But the light emission is weak and of short duration. Thus, the conventional spectrograph with its narrow light-entrance slit cuts off an intolerable amount of the light emission.

The streak camera, said Liu, employs a series of condensing lenses arranged to funnel the maximum amount of light down to a very narrow area onto the photographic plate.

The system employed is considered economical in all respects, its simplification assists in the interpretation of complex reactions by permitting the isolation of associated phenomena.

• **Optics in space**—Spaceborne optics literally will open the skies for astronomical observation, said Dr. Aden B. Meinel, astronomer at Kitt Peak National Observatory, near Tucson, Ariz.

The balloon-borne telescopes used in Stratascope I (12-in.) and soon to be used in Stratascope II (36-in.) are precursors, but they at least permit viewing the visible spectrum without atmospheric losses. Such systems do not permit observations in the ultraviolet region. Television further enhances their data-collection capability.

Rockets have permitted glimpses from beyond the atmosphere, but observations are transient and not accurately repeatable.

Satellites—and eventually the moon—offer a superb astronomical platform, but for some time to come data retrieval will remain a limiting factor.

In his roundup of "New Frontiers of Astronomical Optics," Dr. Meinel also predicted that high-resolution telescopes will not be employed in space until the 1970's.

However, he stressed that the inherent advantages obtained from using outer space for astronomy will permit a 50-in. telescope to achieve an optimum resolution far in excess of the Mt. Palomar 200-in. instrument—the best currently available.

## Potential of Semi-metal Diodes Outlined at APS

NEW YORK—An M.I.T. scientist has proposed a diode made of semi-metals with faster response and lower power requirements, making possible a new control parameter—a magnetic field under cryogenic conditions.

These potentials of substituting semi-metals for the more usual semi-conductors were described recently by Dr. Benjamin Lax, of M.I.T.'s Lincoln Laboratory, at the annual meeting of the American Physical Society.

Such a diode, or "magneto-triode," would be composed of the semi-metals bismuth or antimony, or an alloy of the two, Lax said. The p-n junction would be achieved by doping, consisting of one part per thousand of lead on the "p" or "holes" side, and a similar impurity of tellerium on the "n" side.

Where the energy-level separation of electrons and holes in semiconductors is of the order of one electron volt (ev), that separation in semi-metals would be about 0.05 ev. While the semi-metals employ small degrees of both electron and hole conduction at normal temperatures, doping and operation at liquid helium temperatures removes the overlap, Lax asserted.

At the low temperature, the conductivity can be controlled by application of a magnetic field of the order of tens to a few hundred gauss. Dr. Lax said he thought perhaps a single loop of a superconducting coil would do the job.

• **Doubling performance**—For potential applications in transistors, rectifiers, and switches in computer components, these magneto-triodes would have response times of the order of one-billionth second (one or two orders of magnitude better than present semi-conductors). They would operate in millivolt, microampere and microwatt range.

Such devices would make it possible to operate entire systems in a cryogenic bath, and their noise characteristics would become competitive with masers in amplification.

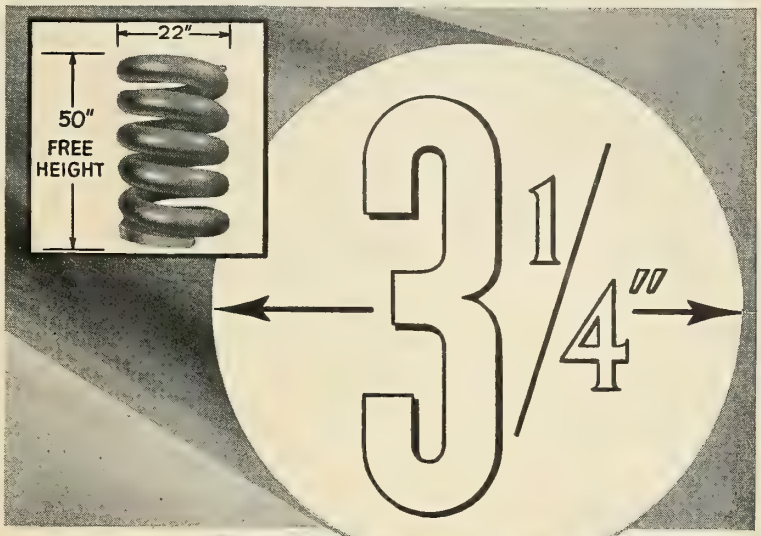
For radar and microwave applications, they could be used in 1-millimeter or 30- to 300,000-megacycle receivers, with very little internal dissipation of power.

Current semi-metal application studies are a result of basic research in magnetic fields and magneto-absorption, Dr. Lax reported. His group is now trying to construct the proper semi-metal alloys, properly doped, for a model using the proposed diode.

Dr. Lax said development of small cooling systems to maintain cryogenic conditions has advanced to the stage where it is practical to thin of an entire computer in the bath with only input and output leads to the outside. ⌗

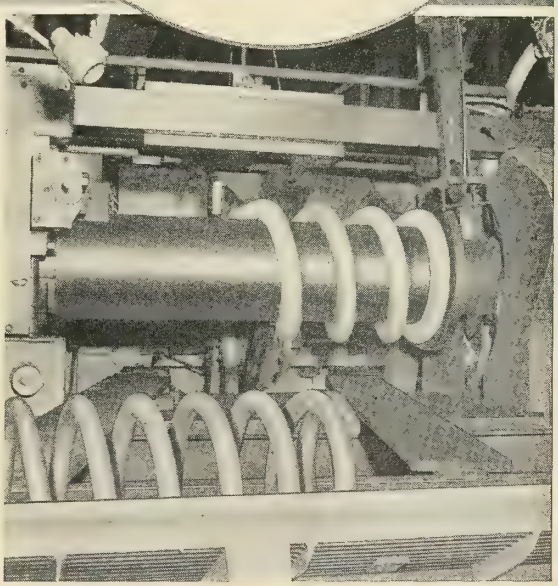

# ONLY ASF HAS IT!

**New machine coils 3 1/4" bar stock into 22" diameter springs for missile silos**




**Springs Pass Air Force Inspection**

Quality production of the heaviest heavy-duty springs at ASF—HAMMOND Division took another giant step forward recently with the installation of this specially designed machine. It coils 3 1/4" bar stock into half ton springs with 50" free height. These springs are uniform in all essential physical characteristics.



*Automatic operation assures unprecedented product uniformity*

This new machine automatically controls coiling time to minimize loss of temperature, which assures effective hardening. This results in new standards of uniformity in the heavier springs. If you have a shock-mitigation problem, why not write today for complete information.

ASF **AMERICAN STEEL FOUNDRIES**
**HAMMOND DIVISION** Hammond, Indiana




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## Weather Satellites

*(Continued from page 17)*

Frank W. Burnett, made these findings:

–Plans for early *Nimbus* launches do not guarantee a satellite in operation at all times.

–The fact that only a single readout station is planned by NASA (at Fairbanks, Alaska) will prevent reading out all orbits and will delay receipt of some data.

–There is need for provision of direct readout of local area pictures by forecast centers.

–Radiation data (from infrared sensors) usable for operations may not be processed on a real-time basis.

–Communications will not be sufficient to transmit to field and foreign forecast offices from the National Meteorological Center the amount of information needed.

–Coverage in the lower latitudes is restricted to one daytime daily view of a given area.

–The time between obtaining observations and the readiness of the resulting weather analyses limits the usefulness of the data, particularly for small-scale forecasting.

• **Continuous system asked**—The Weather Bureau group made these recommendations:

–Procurement of sufficient spacecraft and boosters to assure that at least one *Nimbus* is in operation at all times following the first launch, and acceleration of the development program to assure no further slippage in the first launch.

–Provision of additional readout stations to assure full global coverage.

–Equipment to provide direct readout by ships and land stations.

–Additional communications facilities to assure maximum use of the *Nimbus* data.

–Provisions for operation of two satellites at all times, as soon as the first launches establish the validity of the system.

–Acceleration of data systems design work to minimize the delay between observation and provision of weather analyses to forecasters.

Presumably, the Weather Bureau recommendations have been modified extensively in the three months that POMS has been studying the problem.

The third and fourth *Tiros* satellites will have a modification designed to move in the direction of operational use. Instead of one wide-angle camera, taking pictures 700 miles on a side, and one narrow-angle camera, taking pictures 70 miles on a side, both cameras will be wide-angle.

• **High quality**—Tepper said the wide-angle pictures are far more valuable for operational use, while the narrow-angle shots are more important from the research viewpoint. The first two *Tiros* satellites have provided many research pictures. Provision of two wide-angle cameras will provide redundancy in case one camera runs into focusing difficulty like that of *Tiros II*.

Despite the poor quality of the pictures, Tepper told the Senate committees, *Tiros II* was highly successful. "Considerable cloud information can be extracted even from these pictures. Moreover, the narrow-angle camera pictures are of excellent quality, and the IR data are very promising."

*Nimbus*, which will weigh about 650 lbs. and will be launched into circular polar orbits of about 600 miles altitude, will be the first weather satellite permanently oriented toward the earth. Ultimately, however, the NASA program calls for an *Aeros* satellite, about the same size and general shape as *Nimbus*, which will be launched into a 24-hour equatorial orbit and will carry a zoomar-type television camera for close-up views of developing storm systems.

Although *Aeros* is not officially approved in the sense that all phases of the program have been okayed at the highest level in the agency, Tepper said there are active plans for developing long lead-time components.

Tepper told the Senate committee that the zoomar camera will be a major problem area. He said NASA is requesting FY '62 budget funds to start developing the camera.

• **Common readout**—Another problem area, he said, is stationkeeping—correcting the equatorial orbit to keep the satellite stationary with relation to the earth to compensate for perturbations introduced by the moon and other factors.

Presumably, work in this area is going on in the Defense Department's *Arents* and *Advent* programs, and in NASA's *Centaur* vehicle development program. Tepper said the first *Aeros* might be launched by a *Centauer* in 1964. He said he hopes to develop a satellite with a lifetime of a year. Major problem in developing long life, of course, is the necessity of a large supply of propellant for course corrections.

While work is in progress on developing a U.S. program, many officials are thinking seriously about how an international program would work. Dr. Harry Wexler, chief Weather researcher who first publicly proposed a U.S. weather satellite program in 1954, believes the funding problem can best be solved by letting each nation fund its own efforts.

Wexler suggests each nation give notice of launchings and that all weather satellites use common frequencies, so that readout stations could obtain data with equal ease, regardless of who owned the satellite.

Even the readout stations will prove expensive for some nations, Wexler notes. Thus it may be desirable for several nations in a region to pool funds for readout stations.

An important technical problem yet to be solved, Wexler said, is that of direct readout by many stations, which might impose a heavy drain on the satellite's power supplies. Also, he said it may be necessary to provide nonerasible tape for on-board tape recorders. Bigger boosters, capable of carrying greater weight, may be the answer.

Wexler said he was extremely disappointed that Soviet meteorologists were unable to attend a recent meeting of the World Meteorological Organization called to discuss meteorological satellites. Perhaps they will attend the next meeting, he said.

### NASA's Nimbus contractors

| COMPANY | SYSTEM | AMOUNT* |
|---|---|---|
| General Electric | Prime | $2,100,000 |
| RCA | Cameras & solar power | 302,324 |
| IT&T Labs | High-resolution IR radiometer | 139,235 |
| Santa Barbara Research Center | Medium-resolution IR | 343,426 |
| GE | Control & stabilization | 1,515,710 |
| GE | 5-watt transmitter | 92,652 |
| N. Mexico Coll. Agr. | Antennas | 69,384 |
| RCA | Vidicon and solar power | In negotiation |
| California computer | Clock | In negotiation |
| Ampex | Tape recorder | In negotiation |
| Radiation Inc. | PCM telemetry | In negotiation |

** Contract sums are for research & development and delivery for first two Nimbus launchings*

# AUXILIARY POWER FOR MINUTEMAN'S THREE STAGES

The U. S. Air Force's Minuteman, first of the solid propellant powered ICBM's, introduces numerous design and operational features unavailable in its first generation counterparts. End result is a smaller, lighter, less complex and lower cost missile.

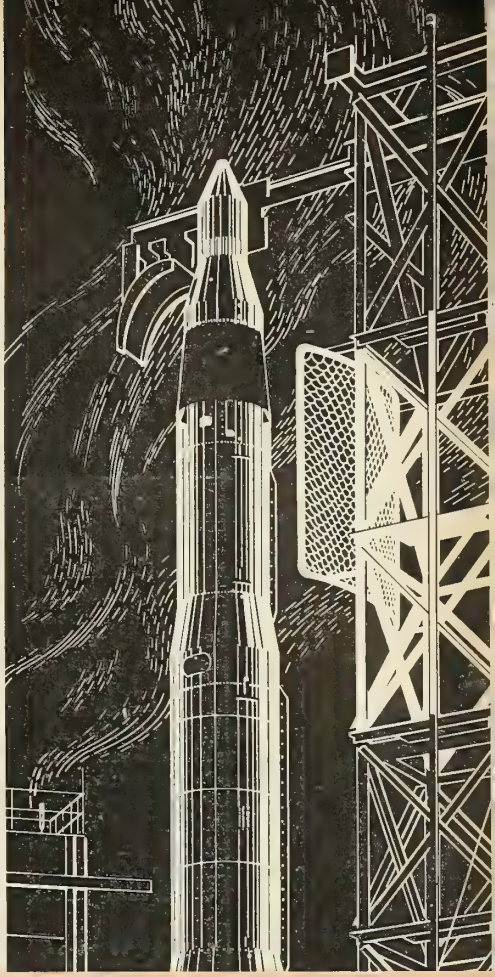
COMPACT DESIGN—Typical of these advances is the highly integrated APU design developed for all three missile stages by Vickers under contract to Autonetics, a division of North American Aviation, Inc. A significant saving in package weight and envelope is provided by immersing the hydraulic pump completely within its self pressurizing reservoir.

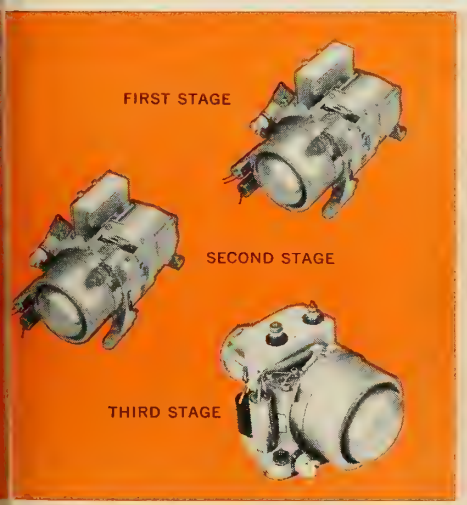
APPLICATION FLEXIBILITY—An important design feature is the ability of the hydraulic pump to be coupled with a wide variety of drives including continuous duty electric motor, ram air turbine, hydraulic motor, flywheel, or be mounted directly on an engine drive pad. For the Minuteman application, an intermittent duty d-c motor is used.

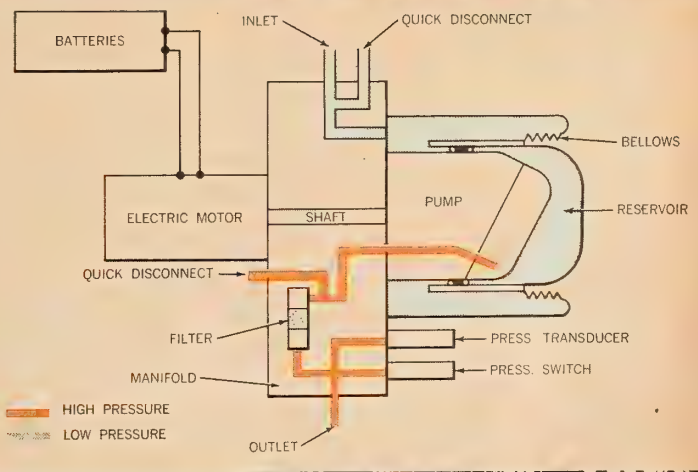
UNUSUAL STORAGE LIFE—A fundamental design goal of the Vickers Minuteman APU was to match the unusual storage life of the missile. This has been accomplished to provide long service-free standby in the missile, coupled with convenient ground check-out.

HIGH RELIABILITY—The schematic diagram below shows the absence of external tubing and the requirement for only one external dynamic seal. These factors along with a proven pumping element and relative low operating speeds have led to a highly reliable system.

This solution is typical of the Vickers "Programmed Power" approach to energy conversion, power transmission and fluid transfer. Get more details on this application by writing for Bulletin A-5249.






AERO HYDRAULICS DIVISION
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DETROIT 32, MICHIGAN
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# Tapco Explores Tungsten Fabrication

***Details of Group's effort to find methods for shaping host of future space parts***

**by John F. Judge**

CLEVELAND—The Tapco Group of Thompson Ramo Wooldridge Inc. is moving along on a carefully planned effort to develop structural tungsten parts.

The Group's Materials Department is in the middle of a five-phase program, sponsored by the Air Force's Air Materiel Command, which began where the current state of the art ends.

Tungsten and tungsten-alloy forgings are expected to be used in manned glide vehicles, re-entry nose cones and leading edges, nozzle throats and blast control vanes, combustion chamber hardware and structural parts for nuclear engines—to tick off a few applications.

But the manufacturing processes required for fabrication of such parts are virtually nonexistent. Dr. A. S. Nemy, research supervisor of the Tapco program, says tungsten " . . . is at the state of development today that columbium was in 1956."

• **Extrusion avenue**—Tapco examined the possible routes of tungsten conversion to bar stock (rolling, swaging, forging and extrusion) and concluded that extrusion, for most applications, offered the best potential.

The firm has successfully extruded reproducible tungsten-alloy forging billets. The alloy chosen was W-15% Mo. Nemy now suggests including a small number of dilute tungsten-base alloys such as W-O.88% Cb and W-7% Mo. He is also eyeing W-O.1% Zr., an alloy which has a large potential but is not yet commercially available.

Cost, properties and design flexibility are the main reasons for the forging program. Nemy says the missile industry would welcome an improved production method of forging throat inserts from tungsten. It would be ideal if thin, integrally stiffened sheets of the metal could be fashioned for exit cones. And there are always the added property values obtained from actually working the tungsten during fabrication.

Tapco's forging plans call for closed-die, precision forgings. This involves three-directional metal flow in the workpiece—a difficult task with a high-melting, obstinate material like tungsten.

The extrusion process is carried out on a 700-ton Loewy horizontal extrusion press. An air-water accumulator system permits pressure loading of up to 184,000 psi on the upset billet. The valving is such that no-load speeds in excess of 30 in./sec. can be achieved, and the press has been operated at 23 ips under 100,000-psi loading. The Loewy machine is approximately five times as fast as commercial extruders.

All billets are heated in a unique, inert-atmosphere induction furnace powered by a 30KW motor generator set operating at 4200 cps. The furnace opens upwards completely in three seconds. Billets are manually-transferred from the furnace to the press in approximately four seconds. The entire press operation consumes another three seconds, which puts the total time from heated billet to extruded bar at 10 seconds.

• **Die wash headache**—The problem centers at the die, where a 4000°F billet is in intimate contact with steel, which melts at around 2500°F. Nemy says that the billet cannot be permitted in the steel liner longer than 0.5 seconds. Experience has shown that the die holds up reasonably well as long as the extruding speed is greater than 10 ips.

A sand-filled run-out box positioned at the end of an 8-ft., run-out tube stops the extrusions. Extrusion velocities, 40 to 60 ips, are sufficient to bury them in sand over their entire length. The bars are then allowed to cool.

Base die material is Vasco Marvel, a hot-work die steel hardened and double-tempered to $R_c$ 50. The entrance face of the die is tapered to a 120° included angle. A portion of the face is recessed 0.020 in. to provide a seat for insulative and lubricative coatings.

Nemy has been using $Al_2O_3$ as an insulator in this recess, but future dies will use zirconia. In addition, the lead-in angle will be flattened and the relief



*WHITE-HOT TUNGSTEN BILLET is positioned in the extrusion press. Three seconds later, the extruded rod will bury itself in a recovery sand box and cool.*

angle decreased to provide more seating strength.

Tapco has established the homogeneity of each extruded bar and uniformity from bar to bar. The results are relatively insensitive to the source of billet supply and the method used in forming the billet.

Billet lubricity has been investigated, but Tapco usually relies on the volatile $WO_3$ formed during the billet transfer. However, too much of the oxide can cause extrusion difficulties.

Reproducibility tests involved the ductile-brittle transition temperature—an extremely sensitive indication of the interstital impurity level; response to heat treatment (recrystallization is indicative of the amount of cold work in the extrusion process); and upset forgeability (the ultimate criterion of reproducibility is the forging itself).

During these tests it was established that the billet stock transition temperature was a low 500°, the forgeability temperature was an equally low 2000°F.

Tapco is not a commercial extruder of common metals, but the unique combination of furnace and press has led to many cooperative programs with uses of refractory metals.

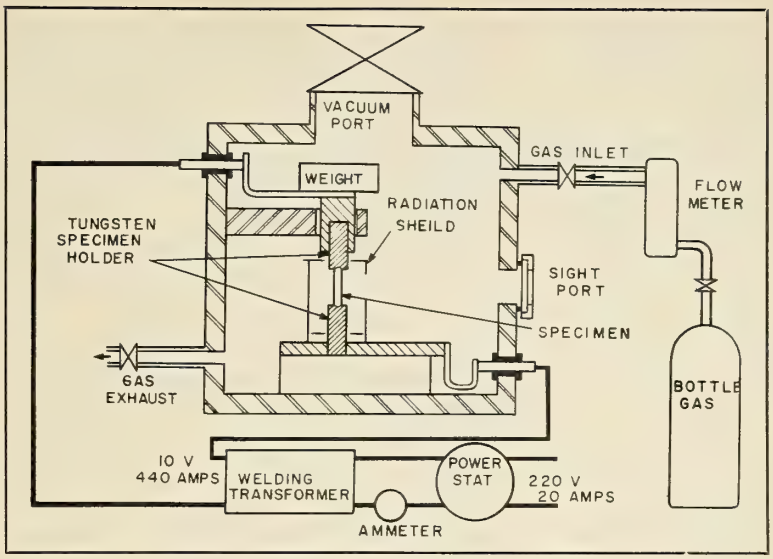
• **Structural forgings**—The next steps in the program move into closed-die ring forging tests. By the end of May, Tapco expects to have forged thin section web structures. A universal forging die will be developd to embody different angles and depths of fill. The results of forging operations with such a die will be translatable to other shapes.

With regard to the fabricability of sprayed-tungsten forms, Nemy says success or failure seems to hinge on the little variables in spraying—purity, atmosphere and speed, to name a few. When successful, such a part is at least as good as a similar one fashioned through powder metallurgy methods.

The results of three years' experience with the forging of columbium alloys at Tapco has contributed to the development of techniques being used in the current tungsten program.

• **Backside reactions**—Tapco has been probing the compatibility of the materials used in rocket nozzles for several years. The study has led to the development of a materials compatibility test chamber which simulated the chemical atmosphere and temperatures of a rocket nozzle.

G. J. Guarnieri, manager, Materials Development, points out that improper materials selection can lead to the formation of low-melting-point constitutents in the critical nozzle throat area. Similar problems may occur as exhaust temperatures are pushed higher and cooled nozzle approaches are




*Nozzle Materials Compatibility Chamber*

adopted. The reaction-studies chamber is being modified to accommodate studies in this area.

Current research at Tapco is aimed at determining the problems lurking in these nozzles. Initial programs will determine the likely coolants; then compatibility studies will begin. Once screening has been accomplished, plasma tests will follow; then, subscale nozzles.

The plasma jet is being used both as a fabrication tool and as a testing device for material evaluation. For evaluation purposes, Tapco had to determine the heat flux distribution across a plasma flame. Empirical studies involving all grades of graphite are an integral part of the nozzle program. Tapco's bench findings are in good agreement with test-firing results.

Guarnieri feels that major factors in the deterioration of graphite in nozzles are chemical reactions and mechanical erosion.

For nozzle inserts, the industry is expanding the use of tungsten. The composite of tungsten inserts with other refractory back-up materials gives rise to a materials compatibility problem. Researchers have learned that certain reactions occur between nozzle structural materials resulting in lower melting temperature products. One solution has been to place a barrier—such as a thin layer of zirconia—between the reactive constitutents.

In the exit cone area, it is likely that phenolic-impregnated graphite cloth or fibers will be the next step. The main problem to be licked is in the processing of the graphite material. Reproducibility and reliability have not yet been attained.

Tapco's activity in exit cones ranges from uprating present compositions to investigating any kind of inorganic refractory fiber material available. The search for better fibers has already resulted in laboratory evidence of the superiority of zirconia to current silica reinforcing compositions with respect to erosion.

Compatibility data is also being compiled with liquid metals. The success of future solar thermomechanical and nuclear space power systems will depend on adequate knowledge of containment materials for these working fluids.

• **Bent tube tests**—One aspect of these studies involves a cost-cutting innovation in the gathering of corrosion data. The usual method is the loop test—a miniature system duplicating the heating and cooling cycle followed by liquid metals in an engine such as the Rankine cycle.

Tapco came up with a simple pyrex or Vycor glass tube, bent at right angles, housing the liquid metal in one end and a corrosion specimen in the other. When heated, the system acts like a reflux condensor, continually depositing fresh liquid metal on the sample. The bend orifice is critical.

Almost 800 bent tube tests have provided information on specimen corrosion, surface treatments, coatings, liquid metal additives, and corrosion/time data. The cost of obtaining the same information from loop tests would have been between $2.5 and 3 million. The actual cost was less than a tenth of this.

Only certain flow rates are possible with the bent tube test; for this reason, thermal gradient data must be obtained on loop tests. Tapco has run the tests up to 1200°F and plans to go higher. ⠿

# EIA Meeting Studies 'Limited War'

***Seminar will give industry first look at new plans for 'brush-fire' war capacity***

"LIMITED WAR" will be the theme in military electronics at the Electronic Industries Association Annual Spring Conference in Washington, D.C., March 14-17.

Lead-off event at the four-day meeting in the Statler Hilton Hotel is scheduled to be a seminar on "Planning for Limited War Requirements." At a luncheon the same day, Army Secretary Elvis J. Stahr, Jr., will discuss the U.S. defense posture; it will be his first major address in the capital since his appointment.

The all-day seminar is expected to give industry its first authoritative picture of the new Administration's plans for America's small-conflict capability.

William Bradley, associate director of research at the Institute for Defense Analyses, will deliver the keynote address on the "Logic of Limited War."

David R. Hull, past president of EIA, will be chairman of an otherwise all-military discussion panel including Brig. Gen. J. T. Snodgrass, USA, Rear Adm. J. A. Jaap, USN, Brig. Gen. R. C. Richardson, USAF, and Brig. Gen. B. A. Hochmuth, USMC.

The annual Government-Industry Dinner (black tie) on Thursday, March 16, will feature an address by Lt. Gen. Bernard A. Schriever, chief of the AF Research and Development Command. He will discuss the role of electronics in space before an invited audience of more than 500 government, industrial, congressional and military leaders.

Other conference highlights include:

–March 15 (AM): seminar on problems of small electronics manufacturers.

–March 15 (PM): seminar to analyze the impact of the Darnell Report on Parts Specification Management for Reliability.

–March 16 (AM): seminar on space satellite communications.

With a record 43 business sessions scheduled, many of the EIA committee meetings also will be held at the near by Willard and Mayflower Hotels. ‡

## Martin Shows Its 'Audio-automation'

CAPE CANAVERAL—Missile support equipment can now be automatically controlled by audio signals pre-recorded on magnetic tape. The prototype of such an "audio-automation" system was recently demonstrated by The Martin Co. at a *Titan* launch site here.

In experimental tests, a flame-bucket water system was automatically controlled from a station 300 yards away. The unit can direct two channels of operations and produce 31 automatic control signals at one time. In the demonstration, two independent water systems on the test stand were operated simultaneously.

Martin says the audio-automatic programer may also be used for checkout and maintenance of equipment, training and simulation, as well as for actual operation of support equipment.

The programer consists of a two-track recorder which provides automatic control tone signals to specified equipment and, at the same time, verbally describes the control command to an operator. The operator monitors the progress of the operation by observing lights on a control panel. The lights indicate the equipment's compliance with the automatic control signal.

If a piece of equipment fails to carry out the command of the tone signal, the operator halts the operation by stopping the tape recorder until the trouble is cleared. Starting the recorder continues the operation.

The tone signals on the tape are coded by using select frequencies. When the signals are received by the equipment they are decoded by means of a frequency-sensitive network. Decoded tone combinations provide the proper automatic control signals to the equipment under operation.

Tape recordings may be prepared in advance of an operation, and used at any desired time. Each recording program may be used over and over again. The signal may also be sent from the recorder to the equipment either by wire or by radio.

The audio-automatic programer is adaptable to systems in missiles, manned aircraft and manned space vehicles. ⌗

## Burroughs' President Cites Costs of Research Funding

IT COSTS MONEY to achieve corporate competency today, according to Ray R. Eppert, president of Burroughs Corp. Earnings must be kept up to meet the need for heavy expenditures in R&D, as well as to maintain a potent marketing team.

During the last five years, he told the New York Society of Security Analysts recently, Burroughs has spent over $75 million in its R&D program (or nearly 6% of its 1955-1959 total gross.) With over 25% of its total revenue from military electronics products the company intends to keep its pure and applied research level high during 1961, said Eppert. To indicate how this investment in pure research pays off he said the company has just announced the first commercially available thin film memory planes.

But Eppert said developments aren't enough. To market such advances Burroughs employs a current marketing team totaling almost 14,000 persons. ‡

## Navy Adds Money for Polaris Sub Transmitters

INTERIM FUNDING by the Navy of an additional $986,000 to Hoffman Electronics Corp. for further development of advanced high-powered transmitters in the high-frequency range will spur work along in this vitally needed equipment for new *Polaris* nuclear submarines.

New funds cover R&D and production of eighteen units, bringing the total allotted so far to nearly $6.5 million. Initial deliveries already have been made, said the Navy.

Designated the AN/WRT-4, the transmitters are designed to meet the unusual requirements demanded by these advanced ships, but they are also adaptable to any other vessel, land vehicles, or even hardened missile sites, according to Hoffman engineers. The WRT-4 employs a fully retractable whip-type antenna.

## AF Funds Further Work On B-52 Navigation

THE AIR FORCE has released $20 million for design, development, and integration of an improved bombing-navigation system that will enable the B-52 to accurately launch ballistic missiles such as the *Hound Dog*.

The ASQ-48 system—now being flight-tested—greatly improves the complete weapons system capability and potential of the SAC jet bomber.

AC Spark Plug, electronics division of General Motors, is system contractor for the ASQ-48. Total funding for production is expected to exceed $50 million.

The new system uses radar and an automatic computer to navigate the bomber both for high-level bombing and low-level flying to avoid enemy radar detection. ⌗

## reviews

**MEN OF SPACE, VOL I,** Shirley Thomas. Chilton Co., Philadelphia and New York. 235 pp., $3.95.

Miss Thomas consulted with important men in the space field and came up with 10 names of men who are "epoch makers" in the conquest of space. Maybe so, although some readers of the book might consider that some of the choices at most titillated, rather than significantly contributed to, space flight sciences.

Here are her choices: Krafft A. Ehricke, Robert H. Goddard, Bernard A. Schriever, John Paul Stapp, Konstantin E. Tsiolkovsky, James A. Van Allen, Wernher von Braun, Theodore von Karman, John von Neumann, and Charles Yeager.

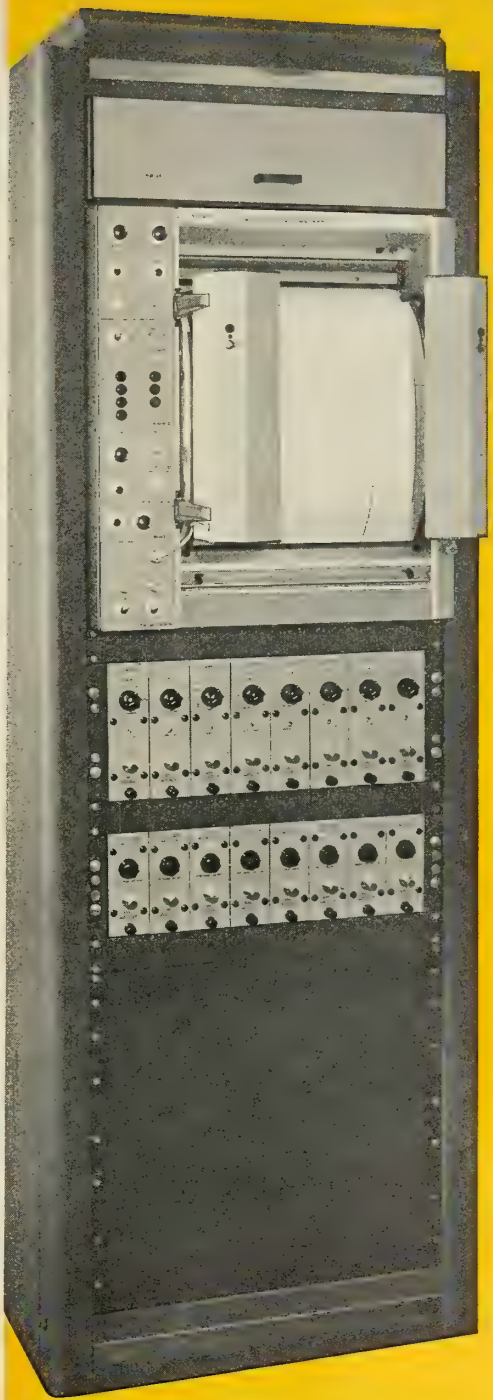
The biographies are clearly written, and with a great deal of color. They deal at length with the human elements of the men many of whom we know only by their technical work. Miss Thomas is amply suited to write in this fashion through her work as a Hollywood interviewer-commentator for NBC, CBS and the Voice of America.

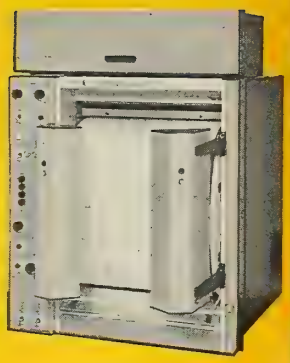
**DIGITAL APPLICATIONS OF MAGNETIC DEVICES,** Senior Editor, Albert J. Meyerhoff. John Wiley & Sons, Inc., Publishers. 581 pp., $14.

This book provides the necessary theory for the design of the major digital magnetic circuit types, and complete design examples of several specific systems.

It is sufficient, in many cases, to enable the professional computer engineer to determine the solution to such problems as: the suitability of a magnetic circuit; the specific component types to be employed; design procedures necessary to design complete systems; specific steps and equations involved in circuit design; and, in great detail, the particular effects of specific parameters of magnetic core characteristics and geometry on circuit design and performance.

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**Along with unmatched mounting versatility, the 5-123 offers the advantages of non-chemical processing using standard print-out papers—and with no latensification delay. Its other key advantages include full front accessibility and pushbutton controls to change speeds instantly from 0.1 to 160 ips while recording 36 to 52 channels of data.**

*Patent Pending

***For complete information, contact your nearest CEC sales and service office, or write for Bulletin CEC 1623-X16.***

*Electro Mechanical Instrument Division* CEC

**CONSOLIDATED ELECTRODYNAMICS / pasadena, california**

*A SUBSIDIARY OF* **Bell & Howell** · *FINER PRODUCTS THROUGH IMAGINATION*

# Banshee H E Blasts Will Probe Near Space

**by Richard van Osten**

NIKE-HERCULES missiles with high-explosive warheads will be fired at balloon-borne targets this summer as part of the Defense Department's Project *Banshee*—a tri-service program to investigate the dynamics of high-altitude explosions.

The two-phase program is jointly administered by the Ballistic Research Laboratory, Aberdeen Proving Ground, and the Naval Ordnance Laboratory, balloon support and launch provided by the Air Force Cambridge Research Laboratory. Tests will take place beteen June and November at White Sands Missile Range, N.M.

In the first phase of *Banshee*, a high-explosive charge and blast instrumentation will be carried to altitude by a balloon (stationary charge and stationary instrumentation).

For Phase II, the balloon will carry blast instrumentation to altitude and serve as a target for the *Nike-Hercules* missiles (moving charge and stationary instrumentation).

Balloons will be launched from sites at WSMR with an additional off-range launch site at Air Base City, Hobbs, N.M. Dry-run launches minus explosives will be conducted from the Hobbs site prior to actual operational flights to obtain balloon rate of ascent and flight trajectory data.

The balloons may as large as 5.27 x $10^6$ cu. ft. in volume. Diameters will run from about 66 ft. at 38,000 ft. altitude to about 240 ft. at 115,000 ft. Balloon length will vary between 100 ft. and 335 ft. over the same altitude range.

In Phase I, 10 balloons with instrumentation systems and explosives will be launched. One will be launched from WSMR. Nine will be launched from the Hobbs site, with three balloons each slated for ascents to 85,000, 100,000 and 115,000 ft.

Phase II operations will include the launch of seven balloons carrying instrumentation systems, but without explosives. One will be launched from WSMR to an altitude of 38,000 ft. Six will be launched from Hobbs—three targeted to 100,000 ft. and three for 115,000 ft.

The balloons will be fabricated of translucent polyethylene and filled with helium. A safety parachute will be suspended below the balloon, and the instrument train will be suspended 200 ft. below the chute.

• **Configuration**—Instrumentation, located at different levels on the 200-ft. extension, will consist of a command control and recording package, four pressure-sensing transducers and a 500-lb. high-explosive charge. The charge will be carried only in Phase I tests. Total weight of the Phase I system will be about 1000 lbs.

Additional instrumentation for the balloon vehicle will consist of a radar beacon and, for Phase II, a pyrotechnic flare which will be ignited by ground command from WSMR to determine miss distance between the balloon and *Nike-Hercules*.

The entire test vehicle, including instrumentation, will be launched as a unit with the 200-ft. instrumentation train deployed from the launch vehicle. This configuration will persist throughout the flight and parachute recovery.

All flight equipment, except the 500-lb. explosive charge and possibly the sensing transducers, will be recovered by a standard, 64-ft. cargo parachute. As suspended below the balloon, the parachute has an overall length of about 80 ft.

Flight duration is dependent upon the altitude desired, varying from two hours to eight hours. It is planned to make all launches and flights during daytime hours. With the instrumentation train, minimum ascent rate is expected to be approximately 500 fpm. There are no plans to have the balloon descend but, if necessary, it will drop at about 500 fpm between 44,000 ft. and the surface.

• **Safeguards**—For safety reasons minimum weather conditions have been established, and the balloon vehicles will be tracked by instrumentation at WSMR. Final launch decisions will rest with WSMR. If there should be any malfunction at vehicle launch, the system provides for release of the parachute, instrument train and explosive charge into an area designated as "safe" prior to launch, or the charge may be detonated before release of the equipment.

The vehicle's minimum rate of ascent between the surface and 44,000 ft. will be 500 fpm. The 44,000-ft. altitude must be reached within 100 minutes, after which the balloon will be tracked continuously and trajectory predicted. Test will not be conducted when trajectory predictions indicate it will not be successful. In that case, the charge will be detonated upon command and the parachute and instrumentation released in a safe area while the balloon rises and eventually bursts.

For further safety, although the general area is sparsely populated, all detonations and/or *Nike-Hercules* firings will take place only if the vehicle is within the confines of WSMR.

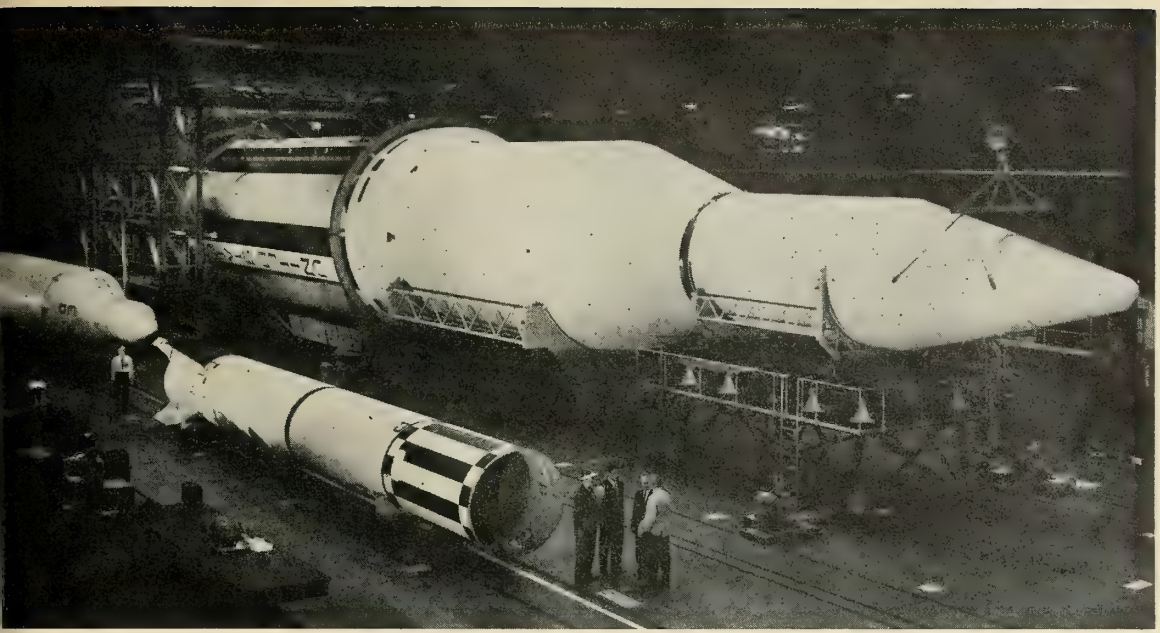
The balloon will be escorted by an aircraft during the flight portion conducted outside of WSMR. Tracking and test status information will be coordinated by land-line communications.



## *Heart of DOD's Global Communications*

*NATIONAL DEFENSE Communications Control Center, heart of a worldwide monitor and control complex, began operation last week under the direction of the Defense Communications Agency, in Arlington, Va.*

*Built by Philco Corp. around its S-2000 digital computer, the center will receive, process and display data reflecting conditions of all the military's non-tactical communications networks. In time, system control will be decentralized at logical areas around the world, and the data base of this center will be enlarged—with the eventual goal of real-time control.*



## Saturn Moves Nearer First Flight

*SATURN BOOSTER MATED with dummy upper stages delivered by Douglas and Convair lies on its side in hangar at NASA's Marshall Space Flight Center, Huntsville, Ala. Flight booster will replace prototype on static test stand in next few weeks. After completion of static and dynamic tests at Huntsville, the flight version of Saturn will move by barge to Cape Canaveral for launching late this summer. Much time lost last fall was made up when NASA discovered that only four firings were needed in the second series of prototype booster static tests, which ended last month.*

# Scout Advances

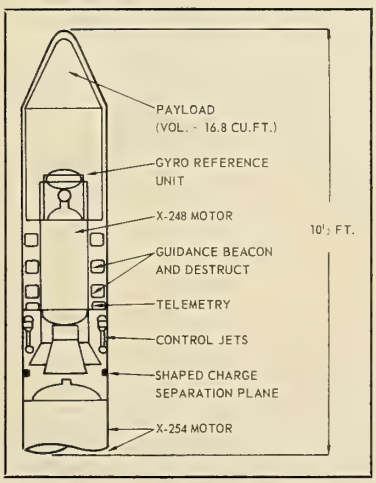
## Successful Flight with Fourth-stage Guidance

*BLUE SCOUT II*—first *Scout* vehicle with guidance in the fourth stage—lifted a 172-lb. payload to an altitude of 1580 miles in its first flight March 3.

The payload, which remained attached to the empty X-248 fourth-stage rocket case, contained six experiments designed by the Air Force Special Weapons Center. The Air Force said radio telemetry information was received from all six on the 40-minute flight before burnup 2000 miles downrange from Cape Canaveral. The experiments were:

Proton telescope, to measure energy flux and angular distribution; electron spectrometer, to measure energy flux and angular distribution; gamma-ray detectors, to measure energy and intensity; neutron detectors, to measure energy and flux; tissue equivalent ion chamber, to determine total radiation exposure at depth of 2 cm in human tissue; Schonstedt magnetometer, to measure intensity of earth field.

*Blue Scout II* is the third in the Air Force family of vehicles based on the *Scout* to be tested. Its stages are identical with those of the basic *Scout*, developed by the National Aeronautics and Space Administration. The major difference is the addition of fourth-stage guidance.




*CUTAWAY of Blue Scout II payload carrier.*

Ford Aeronutronic Division is prime contractor to the Air Force. Chance Vought, prime contractor to NASA, is vehicle assembly subcontractor to Aeronutronic.

The Air Force said five more high-altitude probes are scheduled before the first *Blue Scout* orbital try. ⌗

## Thermoelectric Sulfides Produced by Westinghouse

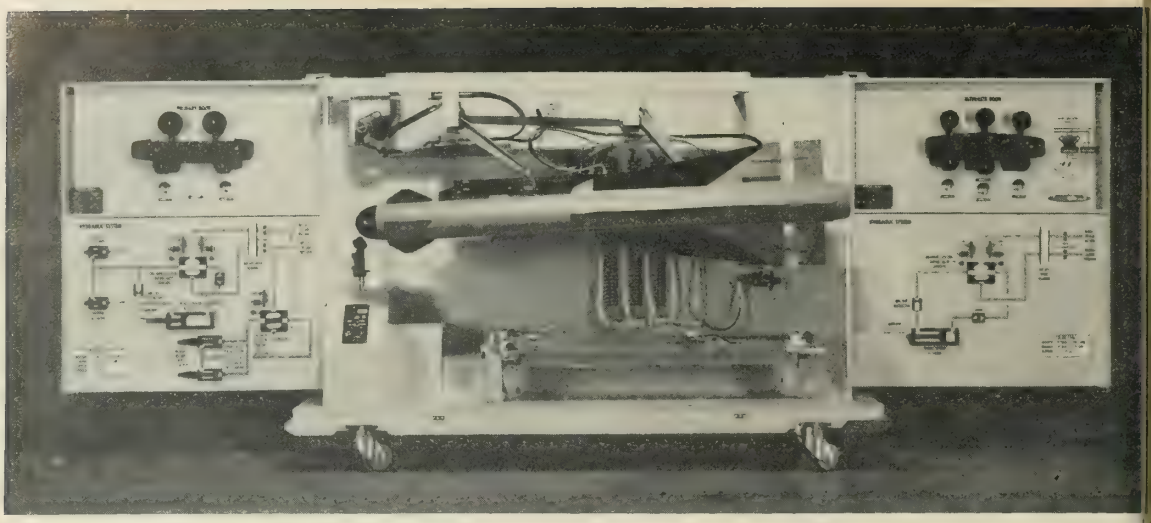
COMBINATIONS of the rare earth metals, samarium and cerium, with sulfur have produced two new groups of high temperature thermoelectric materials at Westinghouse Electric Corp.

The compounds show stability and attractive thermoelectric efficiencies at temperatures up to 2000°F. They can be used at the top of a series or cascade of thermoelectric materials in future power generators. Each series operates in the narrow temperature range at which it functions best and each passes its waste heat along to the next lower temperature material on the scale.

Thus a generator can be operated at a higher temperature, raising the overall efficiency.

The two families of rare earth sulfides are prepared by direct combination with sulfur. Following the reaction, the sulfide is crushed and compacted into cylindrical pellets and sintered. Composition is determined by X-ray diffraction analysis. Physical, chemical and electrical tests are then run on the pellets.

The development is part of a continuing research and development program sponsored by the Navy's Bureau of Ships. ⌗



*TYPICAL OF Burtek's contribution missile training in this Falcon train*

## management

# How Tulsa Firm Moves With Missiles



HILBURN

WITH MORE and more missile systems moving from research and development into the operational phase, missile training aids are gaining in importance as a market. One firm with a strong capability in this field is Burtek, Inc., of Tulsa, Okla.

The firm is the largest builder of training devices for the *Polaris* program, with contracts from Lockheed Aircraft Corporation, General Electric and the Navy.

Its missile control center console, an exact duplicate of the shipboard panel, is in use at the Navy's Pittsfield, Mass., *Polaris* training school. It was used to train crews for the first underwater launch.

Burtek also builds the airborne pressurization and propellant feed system trainer for the *Atlas* program. Now in operation at Sheppard AFB, Tex., this permits the instructor to program predetermined malfunctions which are concealed from students as they progress through countdown prior to launching.

Although successful in the field of training aids, Burtek has no intention of limiting itself to these. With training aids as a base, Burtek is now putting together a number of diverse talents, particularly in electronics, for more general growth in missile/space technology.

The expansion began a year ago when Earl D. Hilburn, a former vice president of Link Aviation, unceremoniously took over the reins of Burton-Rodgers, Inc.

His first move was to acquire the electronics division of Divco-Wayne Corp., Cincinnati, producer of radar moving target indicator (MTI) test equipment and specialized frequency meters. Now, as the Electronics Division of Burtek, it also builds specialized cathode ray oscilloscopes, multi-circuit cable testers, microwave stability indicators and special purpose communications gear.

Next was streamlining of the name. Hilburn chose Burtek to reflect the Burton-Rodgers heritage as well as that of Technical Training Aids, Inc., which the firm had acquired in 1955.

Construction of a centralized, $500,000 headquarters for the firm was started in Tulsa. It is scheduled for completion this month.

• **Concord added**—Two months ago, Burtek annexed Concord Control, Inc., a Boston firm specializing in digital computation, data handling and control systems engineering.

Concord has broadened its research activity into other areas, including automation of map and chart preparation for the Army Map Service, radio-controlled buoys and other instruments for oceanographic studies, and data logging and control devices for use with radio telescopes.

One device is an expendable instr mented buoy designed for more relia and less costly location of impact are in missile and satellite recovery ope tions. Under study is a system for el tronically calculating and correcti distortion due to camera angle a earth curvature in photos taken fr satellites.

Missile training equipment is c area eyed by Hilburn for major expa sion. Although faced by competiti from prime manufacturers interested keeping this business under their o roof, he expects the general shift fr the R&D to operational phase for m siles to create new repetitive traini needs more in line with Burtek's taler

• **More people**—In the meantim with a free hand from 18 stockhold holding about a million shares, Hilbu is concentrating on expansion, dive fication and, where the opportunity p sents itself, new people. His latest ad tion is Edward G. Schwarm, form President of Applied Dynamics, w will be General Manager of the Tu operation.

Sales offices have been set up Los Angeles, Dayton, Washington a New York. As the operations expa these corporate sales offices will han the marketing function for all divisi and subsidiaries.

Hilburn clearly intends to ma Burtek a strong competitor in missi space electronics. His first year president has gotten him off to a go start in that direction.

# North American's Aerospace Laboratory

***A look at $10-million facility designed to further enhance NAA's missile/space capabilities for the future***

EL SEGUNDO, CALIF.—North American Aviation, Inc., boasts the world's largest acoustical facility, environmental test chamber and privately-owned wind tunnel at its new $10-million, 28-acre aerospace laboratory.

The acoustics unit is built around a centenary horn 71 ft. long, 49 ft. wide and 28 ft. high. Equipped with two sirens powered by two 400 hp electric motors, the unit provides for discrete frequency or random noise at sound pressure levels up to 170 decibels, about one billion times that in a busy office.

Provision is made for grazing or normal-incidence specimen orientation, progressive wave or reverberant sound field, frequencies of 50 to 10,000 cps and temperatures ranging from −100° to +1200°F. The throat of the horn will accommodate specimens up to 3 x 5 ft.; the main test room holds an object 6 x 25 ft.

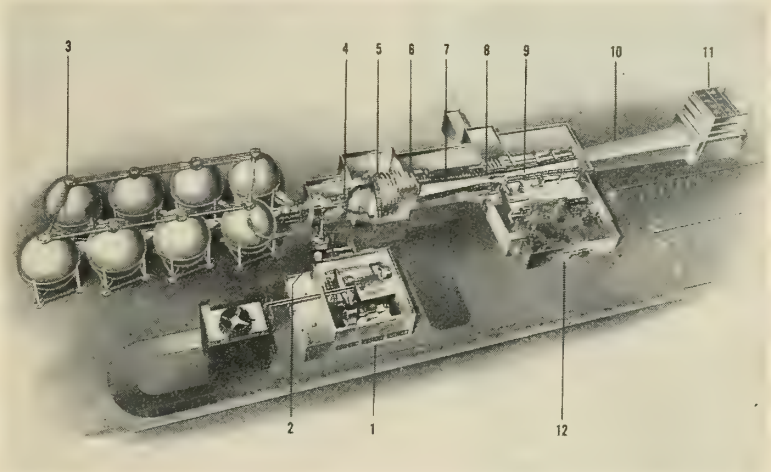
In the 22 x 90 ft. environmental test chamber, the entire forward fuselage section of the B-70 bomber is subjected to altitudes and temperatures up to 140,000 ft. and 2100°F. Rear section of the chamber retracts on rails from the instrumented forward shell.

The new wind tunnel is designed for aerodynamic investigations to Mach 3.5. The intermittent blowdown-type facility accommodates 7 x 7 ft. test sections.

The installation also includes a radome and antenna test facility, a general laboratory and a structures laboratory. A space environmental chamber to test full-size manned capsules at 120 miles altitude will be added. ⁂

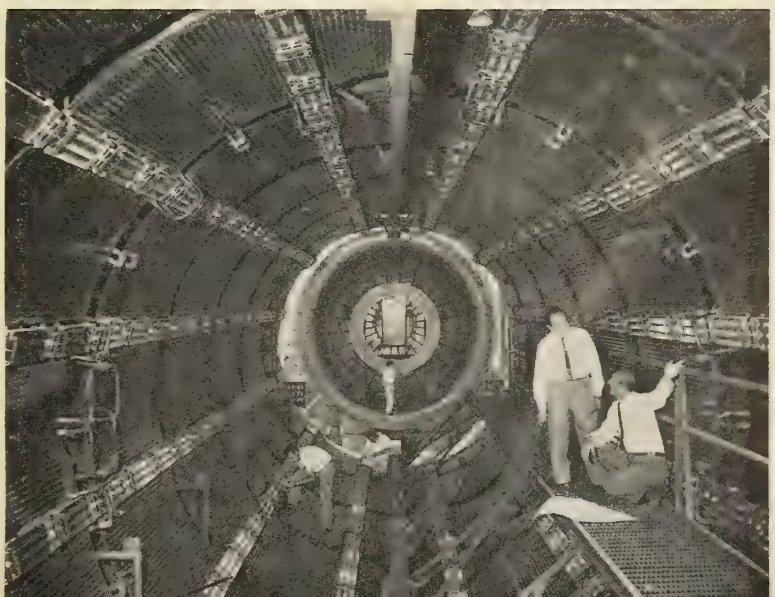


*AEROSPACE LABORATORY, an "earth station for space men," includes world's largest sonic test facility, environment chamber, and privately owned wind tunnel.*




*SKETCH OF TRIOSONIC Wind Tunnel shows 1) compressor building, 2) air dryer, 3) air storage spheres, 4) control valve, 5) settling chamber, 6) fixed nozzle, 7) flexible nozzle, 8) test section, 9) variable diffuser, 10) fixed diffuser, 11) muffler building, and 12) test building. Installation was first completed.*

*ENGINEERS CHECK radiant heat lamps in the 500-ton environmental chamber.*





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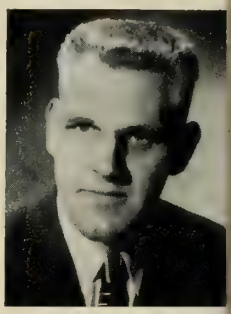
# names in the news



MAYER



FROEHLICH



WERNER

**Herbert R. Keith:** elected president and a director of The Service Bureau Corporation, New York, N. Y. **Frank T. Cary,** former president, promoted to an assistant director of the corporate staff of International Business Machines Corporation, the parent organization.

**Charles Thomas:** named superintendent of missile propellants for Pan American's guided missiles range division at Cape Canaveral, Fla.

**Dr. Frederick Seitz,** head of the Physics Department of the University of Illinois, elected a director of American Machine & Foundry Co., New York. Dr. Seitz also is chairman of the Naval Research Advisory Council and president of the American Physical Society, as well as the author of several books on physics and co-editor of a survey series on solid-state physics.

**Dr. Leland I. Doan,** president of The Dow Chemical Company, elected a director of The Bendix Corporation, South Bend, Ind.

**Dr. George Pheler:** professor of solid-state physics at the University of California at La Jolla, awarded the 1960 American Physical Society prize for developing a method of examining the structure and behavior of atoms in semiconductor materials. Dr. Pheler's development is called the electron-nuclear double resonance technique.

**William W. Drake, Jr.,** named corporate treasurer and will continue as vice president-administration of Aerospace Corporation, Los Angeles. **Robert T. Jensen,** former corporation counsel, appointed assistant secretary and general counsel.

**Cheuk W. Leung:** joins Electro-Optical Systems, Inc., Pasadena, Calif., as research scientist in the solid-state division, where he is engaged in research on the high-temperature thermal and electrical properties of semiconducting compounds and alloys. **William H. Foster** and **Keith L. Winsor** join the Advanced Electronics & Information Systems Division as manager of the advanced technology department and manager of the advanced electronics department, respectively.

**Dr. Louis B. Werner:** joins Hazleton Nuclear Science Corporation, Palo Alto Calif., as vice president. Prior to his appointment he served as scientific representative with the U. S. Atomic Energy Commission in the United Kingdom and Ireland.

**John C. Forrest** and **Dr. Frank N. Gillette:** promoted to the respective positions of director and associate director of the engineering division of GPL Division of General Precision, Inc., Pleasantville, N.Y. **Louis L. Pourciau** is now head of the industrial products department of the engineering division.

**Col. Thomas W. Cooke:** Named Commander of Redstone Arsenal, Ala. **Col. Foster L. Furphy** succeeds Cooke as AOMC Chief of Staff.

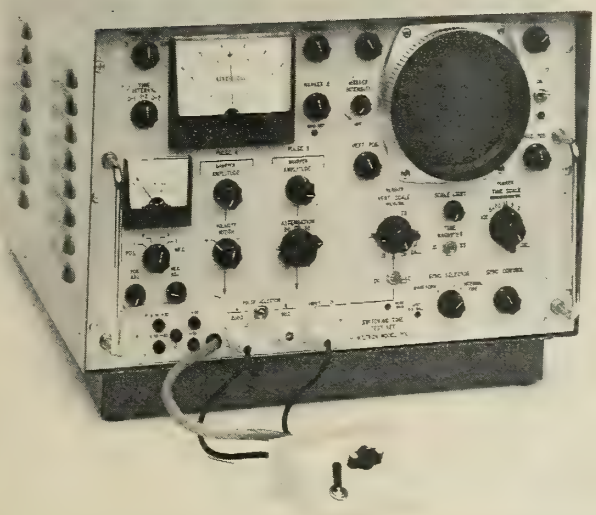
**Dr. Jack E. Froehlich:** Named general manager of Space Electronics Corporation's new Applied Science Division, Glendale, Calif. Dr. Froelich is noted for his project leadership on *Explorer I.*

**Col. Harold W. Norton:** Nominated to receive the USAF Research and Development Award. He is director of rocket propulsion at the Flight Test Center, Edwards AFB, Calif.

**Dr. Choh-Yi Ang:** Appointed manager of Telecomputing Corporation's newly organized Physics Research Laboratory, San Diego, Calif. The laboratory is conducting investigations on energy conversion, new types of electronics devices, and solid-state materials.

**John J. Roscia:** former assistant general counsel, elected vice president and general counsel of North American Aviation, Inc., Los Angeles. **Gerald B. Brophy** senior vice president and general counsel becomes senior counsel advising the board of directors, the chairman and the president on special matters.

**Robert W. Mayer:** Appointed manager, engineering for General Electric's Ordnance Department, Pittsfield, Mass. With GE since 1942 and a recognized authority on servomechanisms, he received the company's highest award for his work on a fully automatic gun fire control system.



## Rapid Switching Time Test Set

Wilton Co. is marketing a switching ime test set, Model 200, making pos- ible the rapid and precise checking of witching times of transistors, diodes, nd computer circuits. It is primarily imed at computers with clock rates f from 1 MC to 100 MC. The device nakes use of the "strobe scope" tech- ique pioneered by Bell Labs which llows an automatic, continuous oscil- oscope sync. and eliminates the need or delay cables.

It has built-in pulse sources, scope isplay, meter readout, bias supplies, nd test jig. Time intervals from 1 nanosecond to 500 nanoseconds can be measured with accuracies of from 3 to 5%. Positionable marker bugs are provided which ride on the oscilloscope waveform and set the time interval for the meter readout. The built-in pulse sources allow a 2 MC test rate with 7 volts into 50 ohms with a 1.5 nanosecond rise time. A completely automatic version is available whereby only the insertion of diodes or transistors into the test circuit is done by hand. Both a voltage output and "Go, No-Go" lights are provided on this automatic version.

Circle No. 225 on Subscriber Service Card.

## Universal Beam-X™ Module

Burroughs Corp. Electronic Tube iv., has available a Universal Beam- ™ Module (DC-112). This unit as counting, distributing, multiplex- g and scanning capabilities. Outstand- g among the features of this module its ability to perform all these func- ons by merely reconnecting the input nd output terminals.

The module, utilizing the general urpose Beam-X® switch (BX-1000), ermits assembly of complex electronic gital systems with a minimum of origi- al circuit design. When used as a ounter, it provides direct drive for NIXIE® indicator tubes, printers, and other circuit devices without decoding matrices or amplifiers such as are required by other techniques.

Circle No. 226 on Subscriber Service Card.

## Diversity Combiners

Telemetry diversity combiners in three models are available from Gulton Industries' Ortholog Division.

Used as accessory equipment to improve signal-to-noise ratios for telemetering systems, the combiners are designed to handle most types of signals, including PCM/FM, PDM/FM and FM/FM with band widths up to 5 mc.

The combiner has 2, 3 and 4 channel configurations, as indicated by the last number of the model designation —OR-DD/2, OR-DD/3 and OR-DD/4. Signal-to-noise improvements as high as 6 db, for four channels have been realized by the combiner, which can operate over input signal dynamic changes beyond 80 db.

Circle No. 227 on Subscriber Service Card.

## Two-Dimensional Board

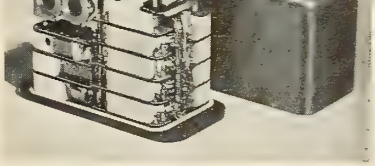
Spec-Tronics has available an all-purpose matrix printed circuit board. The pattern provides a complete set of physically perpendicular circuit connections on both sides of the board. Corresponding holes are provided at each intersection for wiring. These features, in conjunction with the standardized insertion strips, permit ready preparation of customary, cross-over, bus bar and transposition configurations.

Circle No. 228 on Subscriber Service Card.

## Lightweight Command Receiver

An extremely miniaturized Veri-Min command receiver for control purposes in drones, pilotless aircraft and satellites, and for destroy purposes in missile range-safety operations, is available from Leach Corp.

The Veri-Min is a light (24 oz.), small (17.9 cu. in.) solid-state, dual conversion, super-heterodyne set designed to receive tone-modulated FM signals in the frequency range of 406 to 450 megacycles. The unit demodulates and filters the tone signals and



uses them to actuate control relays. It has low power consumption. In its standard form, it has four channels and contains four decoder assemblies, with supplemental packages to provide additional decoder channels.

Circle No. 229 on Subscriber Service Card.

## Hyperthermal Wind Tunnel

A one-megawatt arc-heated hyperthermal test facility capable of accurately simulating critical reentry and ascent trajectories within the laboratory is being marketed by Plasmadyne, a

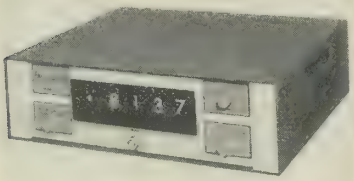
subsidiary of Giannini Scientific Corp.

Standard heat transfer simulation range of the facility using a 3.0 in. diameter Mach number 3 test section, is between 10,000 and 30,000 ft./sec. simulated force-flight velocity. Simulated altitudes are as low as 100,000 ft. at 10,000 ft./sec. and as low as 200,000 ft. at 30,000 ft./sec. At higher altitudes and reduced power levels simulation of velocity to 35,000 ft./sec. can be achieved.

Circle No. 230 on Subscriber Service Card.

## Digital Voltmeter

Electronic Associates, Inc., is marketing the Series 5000 Transistorized Digital Voltmeter featuring very high input impedance that does not depend upon a null condition within the instru-



ment. Solid state computer-type amplifiers are used in a unique loading circuit to achieve the "fulltime" high input impedance.

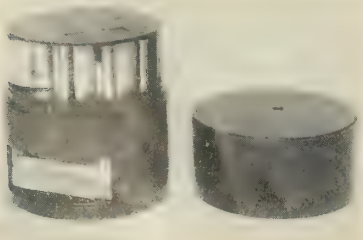
An average of 200 readings per second is achieved with a ±0.01% accuracy relative to either an external reference or the precise internal zener reference. A high brilliance in-line, in-plane projection readout is used to display the four-digit reading, decimal point and sign.

Circle No. 231 on Subscriber Service Card.

## Miniature Tape Recorder

A Miniature Magnetic Tape Recorder, which simultaneously records data (1 to 14 channels, in line or interlaced) from tests conducted under severe environmental and extremely limited space conditions, is available from Aero Data Manufacturing Co.

Model TR-1875 is available in speeds of 1.875, 3.75, 7.5 and 15 inches per second, with a capacity of 150 feet of 1 Mil Polyester Instrumentation Tape providing up to 16 minutes recording. The wow and flutter under static conditions is less than 1%.



Circle No. 232 on Subscriber Service Card.

## Missile TV Monitors

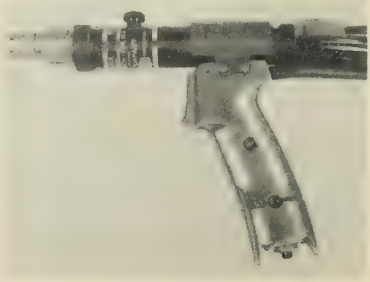
General Electric Co. has developed a series of television monitors which operate with any standard monochrome camera. The sets have an 800-line minimum horizontal resolution.

A design technique prevents interaction of controls. Thus, size, focus and linearity controls can be operated individually, and adjustment of one has no effect on the others. The monitors are equipped with a unique input circuit that substantially cancels out picture disturbance caused by surrounding high-current wires.

Circle No. 233 on Subscriber Service Card.

## Four-In-One Welding Torch

Linde Co. has available a 500-ampere ST-5 torch for all four types of mig welding—spray arc, short arc, plug and spot welding. The versatile torch can be used with all "Sigmatic" mig welding machines, and features an in-line design—all service lines (gas, power, water and wire) enter the torch through the rear of the barrel. As a



result, they can be supported on the welder's shoulder for balanced torch operation.

The ST-5 has a cooling system that brings water directly into the nozzle body to cool the contact tube, permitting continuous operation at currents as high as 500 amperes, even with carbon steel welding wire.

Circle No. 234 on Subscriber Service Card.

## Improved Solenoid Line

Dormeyer Industries has available a Super-T Improved Line of Solenoids designed to replace the former CT Line.

The Super-T is a laminated sole-



noid, with superior electrical and m chanical characteristics, and has stronger seating pull without excessi AC hum. The solenoids may be su plied with moisture resistant, moistu proofed or with coils completely e capsulated in epoxy resin for varyi degrees of protection against humidi water or oil spillage or physical da age.

Circle No. 235 on Subscriber Service Card.

## Washaway Mandrels

Rezolin, Inc., has developed a co plete procedure for producing wash way mandrels 3 in. in diameter a larger, for all types of pressure ves fabrication with reinforced plastic.

The system utilizes hot-melt, wa soluble Rezolin Paraplast materi which are slush molded in laminat epoxy molds. The completed mand has a hard, dense, ceramic-like surfa that will withstand compressive for of up to 19,000 p.s.i. The slush mo ing which can be accomplished in matter of minutes produces an e shell hollow-type structure which c be made to any desired thickness w a very uniform wall thickness.

Circle No. 236 on Subscriber Service Card.

## Micro-Module Circuitry

A "789 Series" of sub-miniature capsulated, transistorized digital a logic circuit modules, constructed high reliability components is availa from the Walkirt Co. These spa saving circuits have all been desig to meet stringent reliability needs; proaching micro-module size yet usi only standard reliability-proved com nents with a mean time before fail (MTBF) of over 30,000 hours at 40 and over 20,000 hours at 100°C fo typical Binary Counter. Other circu have a MTBF of over 136,000 hou

Circle No. 237 on Subscriber Service Card.

# contracts

## NASA

**Minneapolis-Honeywell Regulator Co.**, from **The Martin Co.** for human factors studies in connection with *Apollo*. Amount not disclosed.

**Radiation Incorporated**, Melbourne, Fla., for furnishing the pulse code modulation telemetry system for the *Nimbus* satellite. Amount not disclosed.

$479,598—**Systems Division of Beckman Instruments, Inc.**, Anaheim, Calif., for Model 210 data acquisition systems.

$350,000—**The Siegler Corporation's Hallamore Electronics Division**, Los Angeles, for design and manufacture of a television instrumentation system for *Centaur*. Subcontract from **Convair Astronautics Division of General Dynamics Corp.**

$150,000—**Air Research and Development Command**, Andrews AFB, for additional studies and design of *Saturn* rocket. Subcontract from **Marshall Space Flight Center.**

$79,220—**Chrysler Corporation's Missile Division**, Detroit, for study of corrosion and corrosion prevention in the *Saturn* rocket. Subcontract from **Marshall Space Flight Center.**

$40,710—**Wyle Laboratories**, El Segundo, Calif., for a high-accuracy mass flowmeter for use with liquid hydrogen.

## NAVY

$28,177,129—**Raytheon Co.**, Lexington, Mass., for production of the *Sparrow III* air-to-air supersonic missile.

$5,534,526—**Remington Rand Univac Military Dept.**, St. Paul, Minn., for production of additional computer systems for the Naval Tactical Data System.

$2,119,900—**Yardney Electric Corp.**, New York, for batteries to be used in electric homing torpedoes.

## ARMY

$61,773,644—**George A. Fuller Co.** and **Del E. Webb Construction Co.**, Los Angeles, for construction of operational *Minuteman* facilities at Malmstrom AFB, Mont.

$6,200,000—**Western Electric Co.**, Burlington and Greensboro, N.C., for ground and test equipment for the *Nike-Hercules* missile system. Two contracts.

$2,700,000—**Space Technology Laboratories, Inc.**, Los Angeles, 3-yr. contract to provide systems engineering support and technical consultant services on the *Advent* program.

$2,626,098—**Nortronics Division of Northrop Corp.**, Anaheim, Calif., for *Hawk* missile system repair parts and launchers. Three contracts.

$1,510,872—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* missile ground handling and test equipment.

$1,445,303—**John W. Cowpar Co.**, Buffalo, N.Y., for construction of additional *Bomarc* facilities.

$258,695—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike* missile system spare parts.

$169,197—**Sylvania Electric Products, Inc.**, Waltham, Mass., for study of research in coherent digital phased array radar system.

$139,667—**Raytheon Co.**, Waltham, Mass., for concurrent repair parts for *Hawk* missile system.

## AIR FORCE

**Hughes Aircraft Co.**, Culver City, Calif., a multimillion-dollar contract from **The Martin Company** for technical assistance in activating a *Titan* ICBM base at Mountain Home, Idaho.

**Space Electronics Corp.**, for theoretical and experimental investigation into ultra-low-frequency and sub-surface propagation of electromagnetic waves at long distances.

**Boeing Airplane Co.**, from Advanced Research Projects Agency, for study of nuclear radiation for the Air Research and Development Command. Amount not disclosed.

$1,750,000—**Tool Research and Engineering Corp.**, Beverly Hills, Calif., for stainless steel honeycomb core for the B70, and titanium fabrication and components for the *Hound Dog* missile programs. Subcontract from **North American Aviation.**

$984,152—**Yardney Electric Corp.**, New York, for high-energy batteries to be used in the *Bomarc* missile.

$600,000—**Federal Systems Division of International Business Machines Corp.**, Rockville, Md., for product and manufacturing engineering support for *Sage I* systems.

$29,868—**Block Associates, Inc.**, Cambridge, Mass., for research in development and testing of new techniques pertaining to the design and utilization of rocket-borne spectroradiometric systems.

$26,614—**Electro-Optical Systems, Inc., Solid State Division**, Pasadena, Calif., for research and development in ultrarapid cooling techniques applied to beryllium alloys.




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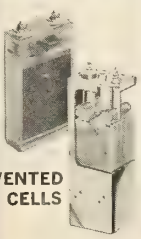
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# letters

## Nike-Zeus Report

*To the Editor:*

So you're back in bed with the Army. Time magazine certainly tagged you properly on that. I see now that copies of your *Nike-Zeus* issue have been sent to President Kennedy and all the members of the House of Representatives. Why don't you stop plugging *Nike-Zeus* and go back to objective reporting?

Richard Lawrence
Philadelphia

*The Nike-Zeus special report (M/R, Jan. 30) is the fourth special report on a missile system we have done in the past eight months. Others: Titan (Air Force), Minuteman (Air Force), Polaris (Navy). Nowhere in the Nike-Zeus report did we state an opinion on whether or not it should go into production.—Ed.*

*To the Editor:*

I have read with great interest your issue containing the series of articles on the *Nike-Zeus* program.

You and your competent staff are to be congratulated for the clear and interesting exposition of a truly complex problem. By the analysis of each phase of the program, you have presented to your readers the full scope of the problem which confronts the President.

It is evident that many hours of thorough research and study have gone into your summation . . .

William W. Quinn
Major General, GS
Chief of Information
Department of the Army
Washington

*To the Editor:*

Congratulations on your recent special section on the *Nike-Zeus*. It is wonderful to have all that information on this important missile published.

I also have kept for my files your special report on the *Polaris* missile.

Lewis Cope
Richmond, Va.

*To the Editor:*

To help me in my work I am writing to ask for reprints of all the articles on the *Nike-Zeus* program.

W. T. Jackson
American Air Filter Co., Inc.
Los Angeles

*Reprints of the Nike-Zeus report are available for twenty-five cents each from Reprints,* MISSILES AND ROCKETS, *1001 Vermont Ave., NW, Washington 5, D.C.*

## Space for Military

*To the Editor:*

Your editorial ("Earth Is for Peaceful Purposes," M/R, Feb. 20) said more on this subject in less than 500 words than everything previous on this subject combined. More than that, it was one hell of a sales argument for which the USAF owes you two chickens. I certainly admire the way you think—and *not* because I'm working for the AF, either

Joe Lucas
Cocoa Beach, Fla.

*To the Editor:*

I was most impressed with your editorial. Keep up the good work.

Congratulations.

Roy E. Marquardt
The Marquardt Corporation
Van Nuys, Calif.

## Dyna-Soar Misgaged

*To the Editor:*

Our mailman is developing round shoulders as an indirect result of your article, "Special Gages Will Record Strain on Dyna-Soar" (M/R, Feb. 6, p. 30). Much of his load consists of letters from potential suppliers asking us if we have shut the door on strain gage competition, as the article seems to imply.

According to the lead paragraphs:

"Measurement of strain on *Dyna-Soar* during flight will be made by special strain gages . . . welded to the craft's surface . . . Microdot, Inc., producers of the device, utilize several unique construction and welding techniques . . . Typical of programs now using the gage are *Titan, Minuteman* . . ."

In the interest of Boeing-vendor harmony, I should like to point out that a specification document for *Dyna-Soar* strain gages has not even been released for quotations. No strain gages—Microdot's or anyone else's— will be selected for use on the *Dyna-Soar* glider until sometime in the future; certainly not until the results of qualification tests are known.

If your reporter was *not* referring to the *Dyna-Soar* glider, but to the modified *Titan* ICBM which will boost the glider, the point was not clear. Our stooped-back mailman is proof that a lot of other people took a flying leap at the same conclusion we did.

Now then, a word about the "use" of the Microdot gage in the *Minuteman* flight test program:

Microdot strain gages were evaluated at Boeing for possible application to the *Minuteman* flight test program. Another vendor was selected, however, and the Microdot strain gages have never been used on any portion of the *Minuteman* program for which Boeing is responsible. It is quite possible, of course, that some other *Minuteman* contractor may have used the gages during development tests.

All this will be verified by Microdot, with whose representatives we have discussed the subject several times.

R. William Jury
Public Relations Manager
*Dyna-Soar* Program
Boeing Airplane Company
Seattle

# when and where

**American Congress on Surveying and Mapping and American Society of Photogrammetry, Convention,** Shoreham Hotel, Washington, D.C., Mar. 19-25.

**IRE International Convention,** Coliseum and Waldorf-Astoria Hotel, New York City, Mar. 20-23.

**American Society for Metals,** 12th Western **Metal Congress,** Ambassador Hotel and **Western Metal Exposition** in Pan-Pacific Auditorium, Los Angeles, Mar. 20-24.

**23rd Annual American Power Conference,** Sherman Hotel, Chicago, Mar. 21-23.

**American Meteorological Society, General Meeting,** Chicago, Mar. 21-23.

**American Chemical Society, 139th National Meeting,** St. Louis, Mar. 21-30.

**4th Symposium on Temperature, Its Measurement and Control in Science and Industry, sponsored by ISA, American Institute of Physics, National Bureau of Standards,** Veteran's Memorial Hall and Deshler Hilton Hotel, Columbus, Ohio, Mar. 27-31.

**American Nuclear Society, Nucleonics in Flight Symposium,** Statler Hilton Hotel, Dallas, Mar. 28-29.

**Society of Aerospace Material and Process Engineers, Filament Winding Symposium,** Huntington-Sheraton Hotel, Pasadena, Calif., Mar. 28-30.


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## Advertisers' Index


Aerojet-General Corp., Sub-General Tire & Rubber Co. 52
Agency—D'Arcy Adv. Co.

American Steel Foundries, Hammond Div. ..... 33
Agency—Edwin Wasey, Ruthrauff & Ryan, Inc.

Avnet Electronics Corp. ..... 12
Agency—Dale & Finkels, Inc.

Bell Aerosystems Co., a Div. of Bell Aerospace Corp. ..... 2
Agency—The Rumrill Co., Inc.

Consolidated Electrodynamics Corp. ..... 39
Agency—Hixson & Jorgensen, Inc.

Delco Radio, Div.-General Motors Corp. ..... 4
Agency—Campbell-Ewald Co.

Engelhard Industries, Inc. .... 47
Agency—Stuart Sande, Adv.

General Materials Co. ..... 7
Agency—Ritter, Sanford, Miller & Kampf, Inc.

Gould-National Batteries, Inc. 47
Agency—E. T. Holmgren, Inc.

Haws Drinking Faucet Co. ... 44
Agency—Pacific Advertising Staff

Hercules Powder Co., Inc. ..26, 27
Agency—Fuller & Smith & Ross, Inc.

Hughes Aircraft Company .. 51
Agency—Foote, Cone & Belding

Kearfott Co., Sub.-General Precision Equipment Corp. .. 31
Agency—Gaynor & Ducas, Inc.

Kern Instruments, Inc. ..... 13
Agency—Richmond Adv. Service, Inc.

Lockheed Aircraft Corp., Georgia Div. ..... 6
Agency—Foote, Cone & Belding

McCormick Selph Associates .. 10
Agency—Long Advertising, Inc.

Minneapolis-Honeywell Regulator Co., Aeronautical Div. 8, 9
Agency—Foote, Cone & Belding

Mitre Corp., The ..... 49
Agency—Deutsch & Shea, Inc.

New Departure Div.-General Motors Corp. ..... 3
Agency—D. P. Brother & Co.

Northrop Corp. ..... 20
Agency—Doyle, Dane, Bernbach, Inc.

Vickers Inc., Div.-Sperry-Rand Corp. ..... 35
Agency—Gray & Kilgore, Inc.

Vitro Labs., a Div. of Vitro Corp. of America ..... 25
Agency—Sam J. Gallay Adv.



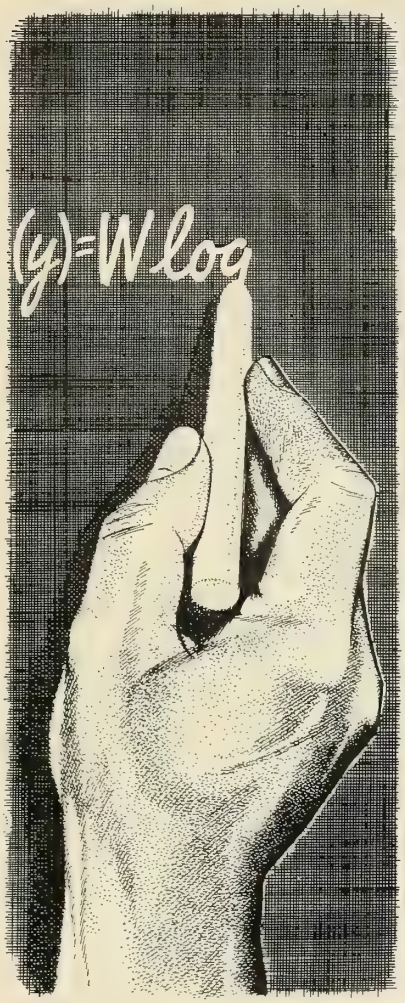
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## editorial . . .

# The Goddard Memorial Trophy

EACH YEAR, the editors of this magazine face the task of selecting the outstanding achievement in the missile/space field during the previous year. To the person or group most responsible for that achievement goes the annual Goddard Memorial Trophy.

Selection of the winner is not a responsibility to be taken lightly. In the four years since it was instituted, the Goddard Trophy has taken on something of the stature in the missile/space field of the Collier Trophy in aviation.

The names of the men who have received it in the past are sufficient indication of that: Wernher von Braun, Samuel K. Hoffman and Karel J. Bossart—three of the industry's outstanding leaders.

This year, for the first time, the trophy is going not to an individual but to an entire organization. As announced in this issue, the winner is the Lockheed Missiles and Space Division.

There is excellent reason for the decision. There were two historic and outstanding achievements in the missile/space field during 1960:

–On Aug. 19, man for the first time recovered an object from orbit, the capsule from *Discoverer XIII*.

–On Nov. 15, the first *Polaris* missiles became operational with the sailing of the George Washington for its Atlantic station.

Recovery of the *Discoverer* capsule climaxed a long and successful program in which much of the real achievement had been overshadowed by the more spectacular efforts to achieve recovery.

The *Polaris* program not only resulted in the birth of a new weapon with a major strategic effect; it was without doubt one of the most successful development efforts ever undertaken on any weapon system.

Prime contractor on both these programs was, and is, the Lockheed Missiles and Space Division.

The Goddard Memorial Trophy, therefore, is going to LMSD for the teamwork and creative engineering which led to the two outstanding achievements in our field in the past year.

To be the driving force behind two such programs is something of which LMSD can be proud. Every person employed at the division can feel a glow of pride and accomplishment at being part of such a team.

When it is realized that only a few short years ago, there was no Lockheed Missiles and Space Division, that the fields where its major buildings now stand were in agricultural use, one can truly appreciate the magnitude of what has been accomplished.

To make the agile shift into the missile/space field required farsighted and courageous management. But it required more, much more. It required a truly dedicated engineering and production team to make the goals of management come true.

THIS AWARD is for all of them. For the executives who made those hard middle-of-the-night decisions, for the scientists who mapped out the parameters of the programs, for the engineers and draftsmen laboring over designs, for the secretaries who shuffled papers, for the girls on the assembly lines at Sunnyvale, for the men on the firing stands in the Santa Cruz mountains, for the crews who sweat out the bad ones and cheered the good ones at Canaveral and Vandenberg.

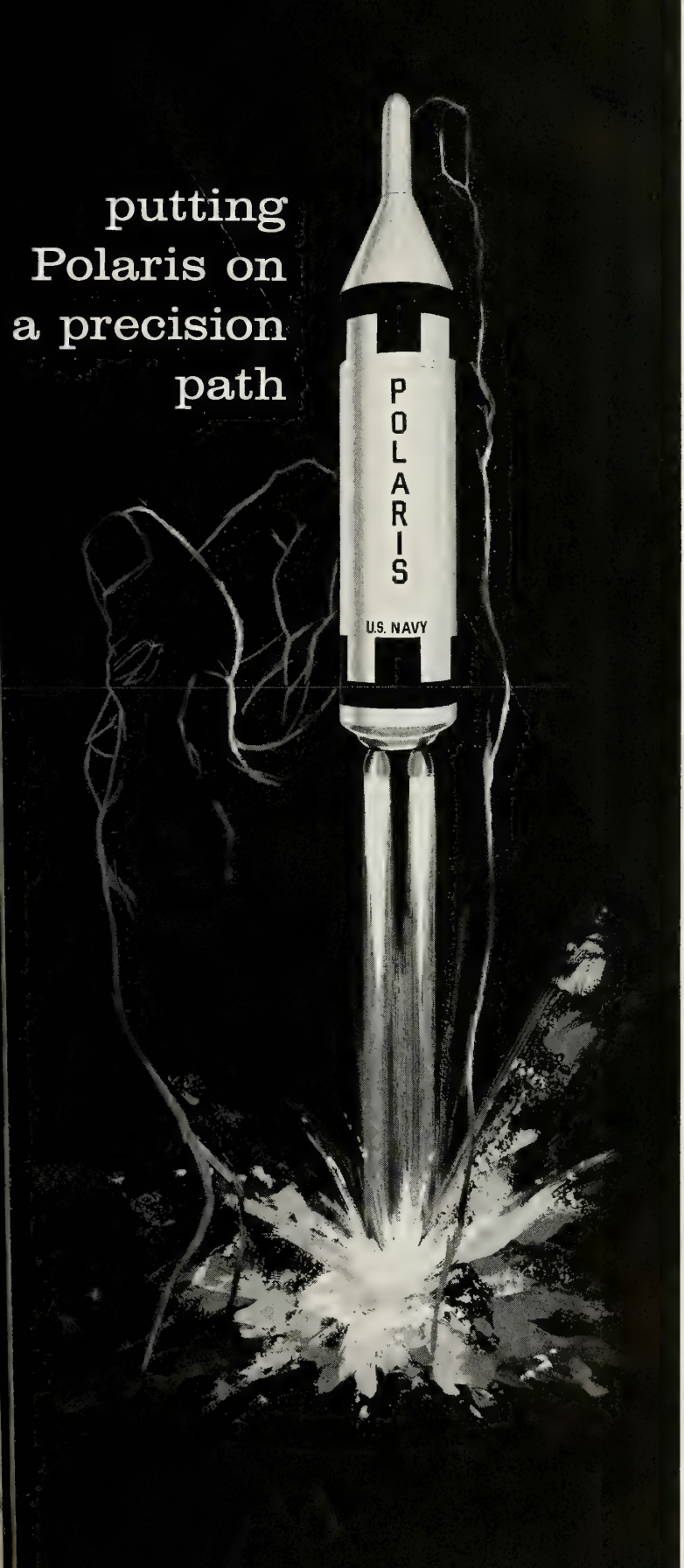
For all, an honor well-earned.

There are many of us who remember with a certain nostalgia Lockheed's wartime slogan: Look to Lockheed for Leadership. The team at LMSD has made us do just that.

We are certain the Air Force, the Navy and all the associate and subcontractors who worked on the two programs join us in saying:

Well done, Lockheed.

**William J. Coughlin**




**Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:**

- Inertial Components and Platforms
- Systems Design and Physical Design of Inertial Devices
- Digital Computers
- Servomechanisms
- Controls Systems Analysis
- Magnetic Drum and Magnetic Core Circuit Design
- Transistor Switching and Circuit Design

Polaris Guidance is but one of the many R&D programs which reflect the growing emphasis on space oriented projects at Hughes. The Engineering Division is also responsible for such projects as: Space Ferry Systems, Anti-ICBM Detection Systems, Infrared Search Systems, and Communications Satellites.

For immediate consideration, please write, wire or call: **Mr. R. A. Martin**
Supervisor, Scientific Personnel
Hughes Aerospace Engineering Division
Culver City 13, California.

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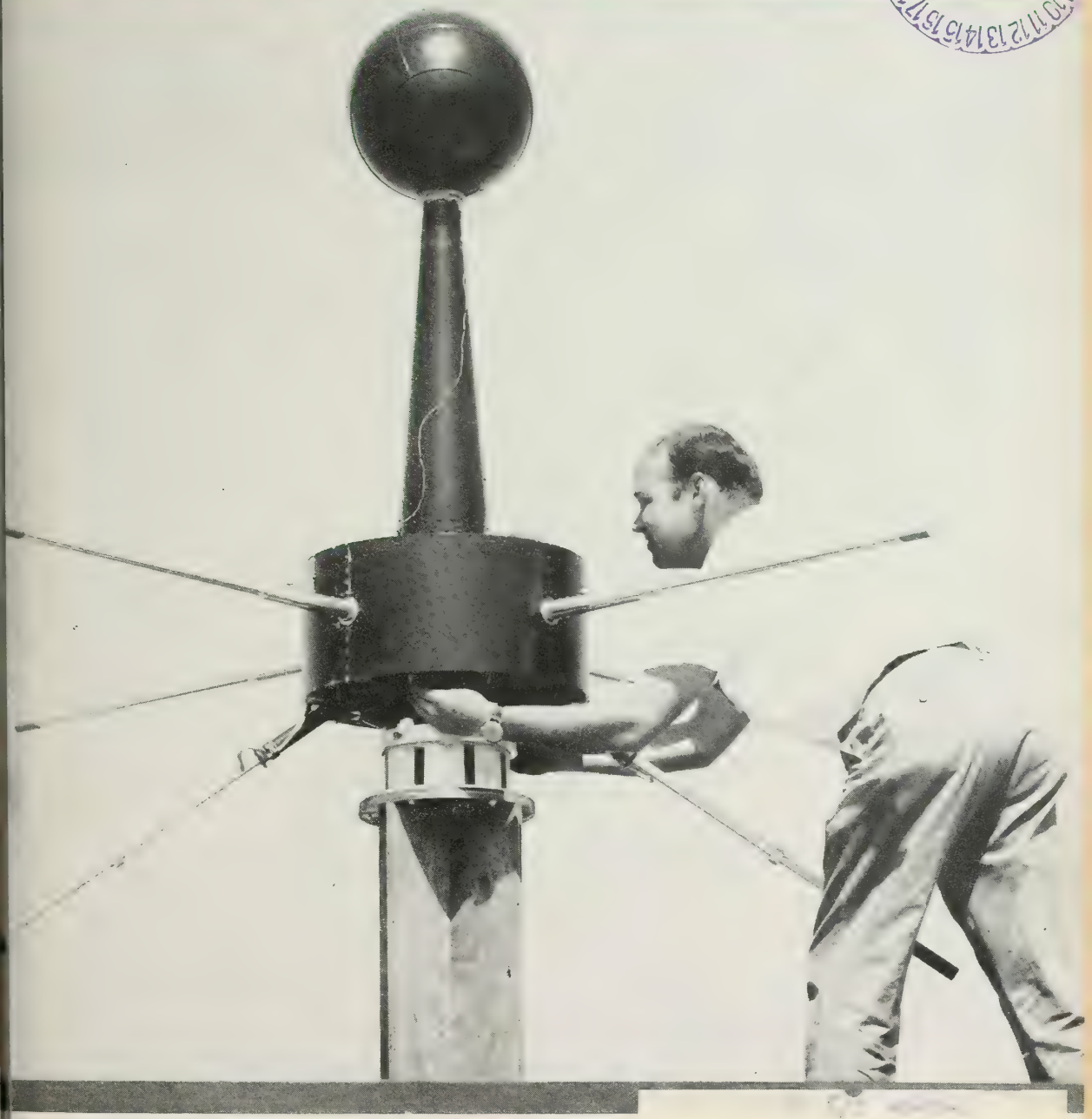

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MARCH 27, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

MAR 1961
Houston, Texas



14—Magnetic Field Mapper

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ECIAL REPORT

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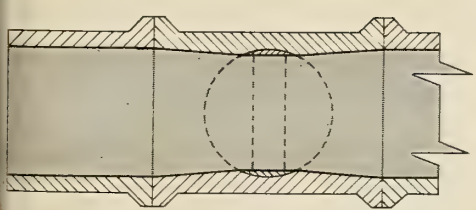
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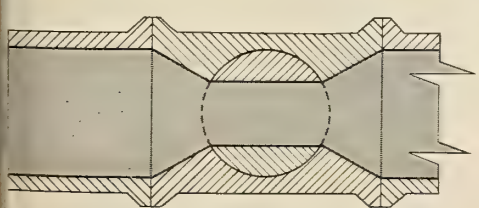
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*Note:* All Clary valves are cleaned, tested, assembled, and hermetically-sealed in a LOX-clean environment White Room that has been inspected and approved by major missile manufacturers.

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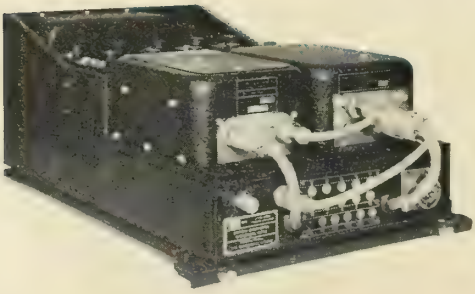
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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, Number 13 March 27, 1961

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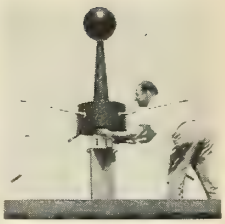
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## THE COVER

*NASA's P-14 spacecraft in extended form it will take when it travels through cislunar space to measure magnetic field with extreme sensitivity. See story on p. 17.*



## MARCH 27 HEADLINES

U.S. Army Nears Big Buy of French Antitank Entacs 14
Administration Buckles Down to Space Policymaking 15
Atlas G Awaits Requirement as Space Booster .... 16
NASA's P-14 to Map Deep-Space Magnetic Field .. 17
Army Map Service Speeds Work with Concord System 33
Seventh Little Joe Shot Coming in Mercury Series .. 37

## SPECIAL REPORT ON WIRE AND CABLES

Industry's Costly Problems Are Solved Too Slowly .... 20
Study Shows Army Could Cut Items More than Half .. 22
Troubles with Materials Are Varied and Critical .... 24
Standardization 'Engineering' Is Urgently Needed .. 28

## SPACE SYSTEMS

First of NASA's 'Streetcar' Satellites Due Soon ..... 34

## ELECTRONICS

IRE Convention Is Biggest Technical Meeting Ever .. 38

## INTERNATIONAL

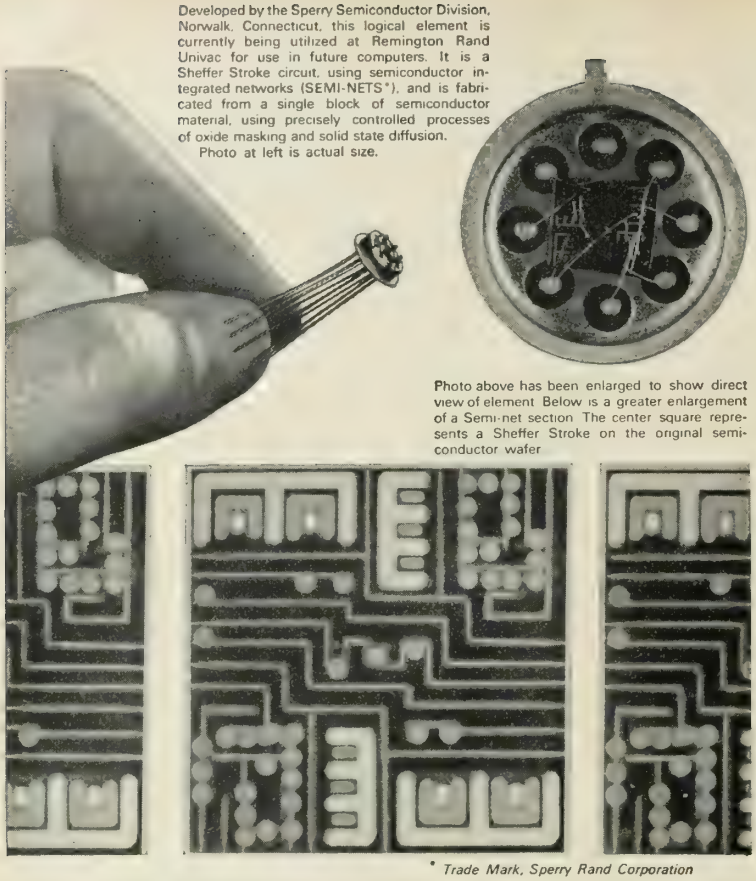
Boom Is on at Australia's Big Woomera Range .... 42

## DEPARTMENTS

Letters ..... 6
Publisher's Memo .... 9
The Missile/Space Week† ..... 10
The Countdown ..... 13
Technical Countdown . 19
Industry ..... 40
Soviet Affairs ..... 41
Products & Processes .. 45
Contracts ..... 47
Names in the News .. 48
When and Where .... 49
Editorial ..... 50

†U.S. Reg. Pdg.

*33,096 copies this issue*



Developed by the Sperry Semiconductor Division, Norwalk, Connecticut, this logical element is currently being utilized at Remington Rand Univac for use in future computers. It is a Sheffer Stroke circuit, using semiconductor integrated networks (SEMI-NETS*), and is fabricated from a single block of semiconductor material, using precisely controlled processes of oxide masking and solid state diffusion.

Photo at left is actual size.

Photo above has been enlarged to show direct view of element. Below is a greater enlargement of a Semi-net section. The center square represents a Sheffer Stroke on the original semiconductor wafer.

* Trade Mark, Sperry Rand Corporation

Advanced technological programs at Univac continue to offer interesting, challenging career opportunities for experienced and capable people. In every phase, from basic research to the realization of a total system, Univac personnel enjoy the personal satisfaction and reward of working with an industry leader who is moving rapidly ahead.

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# —letters—

## Many-Sired Silos

*To the Editor:*

In the Oct. 17, 1960, issue of M/R you had an article on the "Father of the Minuteman-on-Rails."

I found this very interesting and I am very interested to know who was the father of the ICBM "silo" launching technique.

James E. Nichols
San Bernardino, Calif.

*M/R has researched considerably, without success, to determine the "father" of the silo concept. The Air Force says the basic approach was British and, to some degree, Swedish. The idea grew from original consideration of using quarries, mine pits, and other ground depressions. Many people—including Lt. Gen. Schriever, were involved in BMD decisions to go to hard sites.*

*One industry expert questioned on the subject said "I would not venture to say who the father of the silo might be, but I'm sure the idea is the child of a promiscuous woman."—Ed.*

## Guidance Makers

*To the Editor:*

In the TECHNICAL COUNTDOWN of the March 13, M/R was an item headed "Arma Leads Guidance Producers," in which mention is made that the marketing information reported is based on a recent industry report to M/R. This leads me to believe that this brief article was prepared from a comprehensive product and/or market survey. If so, I'd be most interested in learning of the complete study and whether it can be obtained on a loan basis.

Donald R. Herzog
Sr. Military Marketing Analyst
Texas Instruments, Inc.
Dallas

*The major guidance producers and their present and future market alignment were derived from many reports collected by M/R from marketing groups throughout the industry. Other findings on the guidance market were presented in M/R's Annual Electronics Issue, Feb. 27.—Ed.*

## UFO 'Snow Job?'

*To the Editor:*

When as respected a member of Congress as House Majority Leader John McCormack states, as he did a few weeks ago, that "I feel that the Air Force has not been giving out all the information it has on the Unidentified Flying Objects," this reader feels that it is long past time for MISSILES AND ROCKETS to take a close, hard look at the USAF's saucer snow job and get *all* the facts out in the open. The National Investigations Committee on Aerial Phenomena is located right close to your Washington offices—why not drop in and get their side of the UFO story?

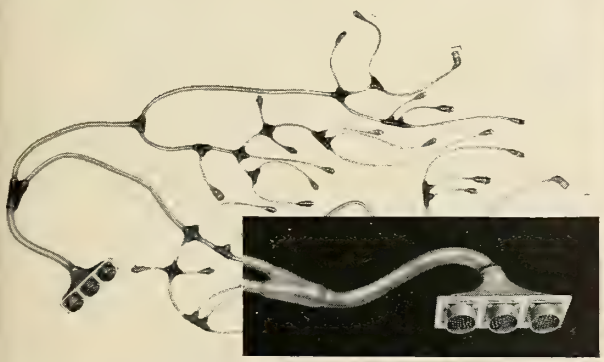
George W. Earley
Bloomfield, Conn.

*What's new in Bloomfield?—Ed.*

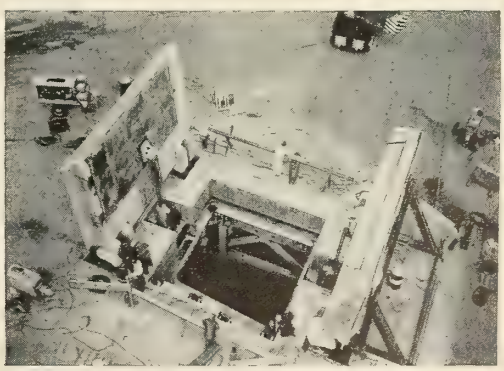
# General Electric Silicone Rubber helps get Titan ICBM combat-ready




**Missile and ground-support applications** are "naturals" for the unique qualities of silicone rubber—heat resistance above 600°F, low-temperature flexibility to −150°F, good thermal conductivity, unexcelled ozone resistance and virtually unlimited life under normal conditions. Because it retains its excellent electrical properties over a wide temperature range, G-E silicone rubber is also used for missile wire and cable insulation. Even when continuously exposed to direct flame, it forms a non-conducting ash which gives off no toxic fumes.



**Missile wiring harness**— General Electric silicone rubber was chosen by Aerojet-General Corp. for the Titan's propulsion system wiring harness. Breakouts and junctions are molded from G-E RTV (room temperature vulcanizing) silicone rubber; wiring is silicone insulated; jacketing is high-strength G-E silicone rubber. Inset shows silicone rubber inserts in connectors. RTV is used in other missiles as a shock-absorbing encapsulant and potting material for electronic assemblies.

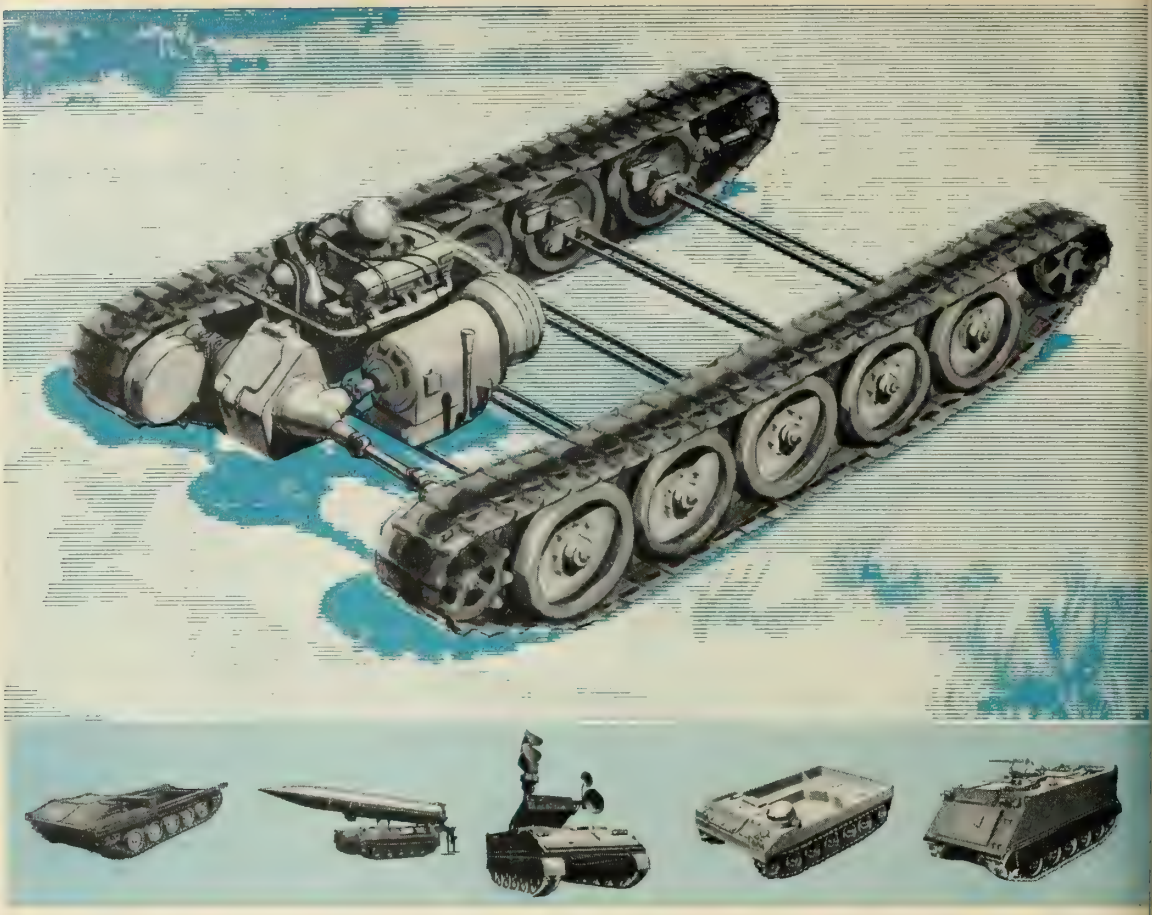


**200 tons of steel and concrete**— Titan missile silo doors by American Machine & Foundry Co. use seals of G-E silicone rubber. AMF also used G-E silicone rubber door seals on the Titan's ground support entry portals and radar silos. Silicone rubber can withstand the heat of rocket blast-off or possible atomic attack while remaining stable in storage for long periods.

**Write for more information on G-E silicone rubber, briefly describing your application. Section 0334, Silicone Products Department, Waterford, New York.**

**GENERAL ELECTRIC**

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# STANDARDIZATION CUTS R & D COSTS AND REDUCES MILITARY LOGISTIC BURDEN

Food Machinery and Chemical Corporation, working closely with the Ordnance Tank Automotive Command and the using forces, has put the standardization idea to work.

A prime example is the modern Army's multipurpose vehicle family. Based on the M113, an entire family of vehicles ranging from armored personnel carriers to unarmored missile carriers has been developed that uses the same engine, power train and suspension as interchangeable components. This standardization saves research and development dollars, adds production economy, and eases logistic problems in field operation.

Take advantage of these cost saving factors in planning your mobile GSE equipment. Call in FMC engineers at the concept stage of your project.

*For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone CYpress 4-8124.*

*Putting Ideas to Work*

FOOD MACHINERY AND CHEMICAL CORPORATION

**Ordnance Division**

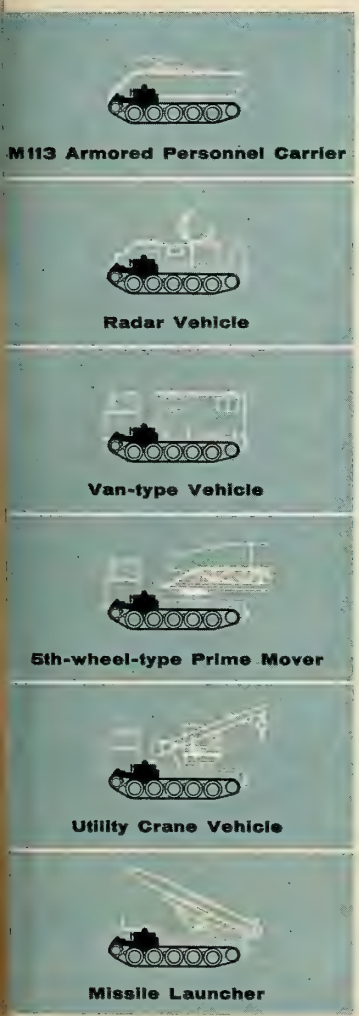
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fmc

Illustrated below are just six of the operational or proposed adaptations of the standard multipurpose vehicle family. All feature full track suspension to insure full off-road mobility on any terrain. Vehicles can be amphibious, air transported and parachute dropped.






*ASSOCIATE EDITOR Hal Gettings double-checks final copy.*

# memo from the publisher

THE SPECIAL REPORT has become so popular with M/R subscribers, as we mentioned on this page several weeks ago, that we're planning to add more of them to M/R's 1961 schedule of weekly coverage-in-depth of the missile/space industry. Not to be confused with M/R's 5 annual special issues —on the general subjects of Electronics, Research and Engineering, the Missile/Space Encyclopedia, GSE, Advanced Materials—M/R Special Reports are designed to do a timely reporting job in depth on a particular missile/space system, material or component.

Future reports currently under consideration will cover a wide range of critical challenges to the industry, as well as specific missile and space programs. This week's Special Report, beginning on page 20, covers the more pedestrian but very vital area of Wire and Cable and its missile/space applications.

A tremendous amount of editorial spadework goes into a Special Report before it finally appears within the pages of an issue. Associate Editor Hal Gettings, pictured above, tells us that in his capacity of Project Leader for Wire and Cable he put in weeks of editor-hours contacting companies working in the field and checking out his findings with people in both government and industry, before this week's issue went to press.

Georgia Tech graduate Gettings claims, incidentally, that an "editor-hour" is worth approximately twice as much in kinetic energy as a man-hour, and not just half as much, as has been rumored around our shop.

* * *

AT THE 4TH ANNUAL Missile/Space Industry Conference sponsored by the National Rocket Club here in Washington last week, members of the Missile/Space Market Outlook panel were barraged with questions concerning the objectives of the U.S. man-in-space program. Raytheon's Dr. Martin Schilling, Senator Howard Cannon of the Senate Space Committee, G.E. MSVD's Al Christiensen, Thiokol's Dave Eaton, M/R Editor Bill Coughlin and others did a masterful job of defining these objectives.

All agreed, however, that the subject needs further airing. And in M/R's next regularly scheduled Special Issue, titled "Research and Engineering for Man In Space," the editors will attempt to put on paper both the military and commercial objectives of the country's Man-In-Space program, and go into lengthy detail on where we stand and where we're going in the areas of space vehicles, boosters, materials, electronics, GSE, space medicine and re-entry.

M/R's "Man-In-Space" issue has already stirred up a great deal of interest in military, NASA and industry circles. Watch for it; with luck it may turn out to be our best editorial effort yet. Publishing date: May 29.

Edward Mukhefeld



# R/M ASBESTOS-PHENOLICS

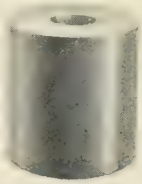
## molded stock saves tooling up for prototype parts

Why pay for expensive dies and equipment for molding high-temperature test parts of reinforced plastics? Machine them from standard rods and tubes available from R/M in a broad range of sizes.

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# The Missile/Space Week

### AOMC Centralizes Supply

The Army Ordnance Missile Commmand has created its own central supply organization to support its agencies in weapons systems management.

The Missile and Rocket Inventory Control Center will be composed of about 258 employees transferred from the Army Rocket and Guided Missile Agency and Army Ballistic Missile Agency. It will become part of Redstone Arsenal.

### Three Manned Redstones

The first *Mercury Redstone* manned flight will be followed by two more at six-week intervals.

Dr. Robert C. Seamans, associate administrator of the National Aeronautics and Space Administration, told the House Space Committee last week that all three astronaut finalists—John Glenn, Alan Shepard and Virgil Grissom, thus will have opportunities to make *Redstone* flights.

There is a possibility of a fourth *Redstone* flight by one of the other astronauts, he said, but that has not been decided.

Seamans indicated that NASA does not agree with a suggestion by Rep. James Fulton (R-Pa.) that the first astronaut be chosen by drawing lots. He said there are differences in abilities and NASA wants to be sure the best man is chosen.

### Shots of the Week:

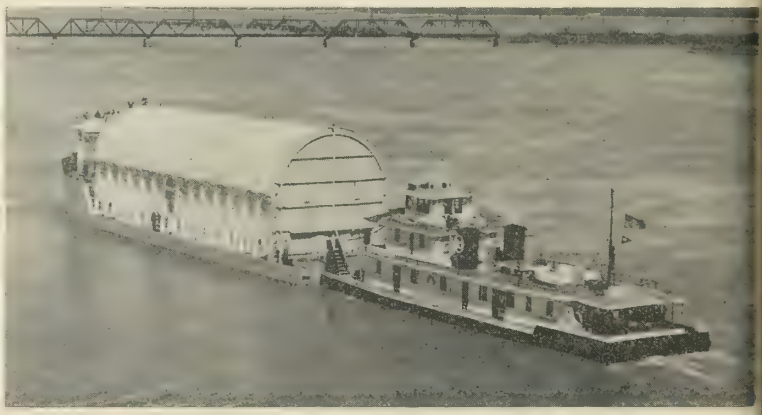
Next altitude attempt for the *X-15* may come sometime this week. NASA's *X-15* pilot Joe Walker spent an anxious moment Tuesday when the B-52 mother ship blew a tire landing because of heavy braking when its drag chute failed to operate. Both ships were landing together—with a heavy fuel load—after a power failure in the research plane forced cancellation of its flight. The fire was put out immediately but it caused some delay in the program for repairs.

At Cape Canaveral: An advanced *Polaris* hurled a dummy warhead almost 1400 miles Mar. 15; the Army launched *Pershing* from its mobile, tracked vehicle for the first time; the next day a *Mace B* sprinted evasively down the AMR on a test of programmed altitude and course changes in its inertial guidance system.

### Key Post to Welsh

Dr. Edward C. Welsh, 57, an aide to Sen. Symington (D-Mo.) will be executive secretary of the National Aeronautics and Space Council.

President Kennedy last week nominated Welsh to the $20,000-a



**Saturn Prototype Rounds Another Bend**

*SHAKEDOWN CRUISE of the Palaemon, NASA's barge for the Saturn booster carried the prototype static-test booster down the Tennessee River from Huntsville, Ala., through the Wheeler and Wilson Dam locks to a point near the Alabama-Tennessee line. Another trial run is planned for April, before the barge carries the flight Saturn to Cape Canaveral for first test later this year.*

year post. He will be the first to fill it on a full-time basis. Although it was established by the Space Act of 1958, the Eisenhower administration always filled it with officials who had other jobs.

## NASA Trims Life Science

The National Aeronautics and Space Administration is cutting down on its plans for life science facilities.

Dr. Clart T. Randt, director of NASA life science program, told the House Space Committee last week he has withdrawn a proposal in the budget submitted by former President Eisenhower for a $700,000 vivarium to house animals at the new life sciences center at Ames Research Center. He said he hasn't given up the idea but hopes to modify existing Ames facilities.

Rep. Emilio Q. Daddario (D-Conn.) questioned whether NASA's other life sciences plans do not duplicate facilities of the military services. Randt replied that NASA merely wants to establish a small staff of experts with capability to monitor the 75% of its life sicence work, which he said will be done by the services and universities.

## Saenger on Photon Rockets

Prof. Eugen Saenger declared last week that there is no thrust limitation on the photon rocket like that on electrical propulsion.

Saenger told an American Rocket Society meeting in Washington he is confident that, in time, photon rockets will be developed with thrust-weight ratios comparable to present-day chemical rockets—and with specific impulses upwards of 10,000 sec.

The major technical problem in photon rocketry is focusing the electromagnetic radiation in the spectrum region near the X-ray-ultraviolet border. He conceded that solid surfaces apparently will not do the job. He has hopes, he said, for the use of plasmas with electron density about 1000 times as great as solid metal.

Saenger reported also that his laboratory in Germany has developed a steam rocket with 60,000 lbs. thrust and a specific impulse of 50 sec. The cost is much lower and the rocket is much safer than conventional rockets, he said.

## Venus Re-observed?

The Soviet Embassy in Washington said last week that contact has been resumed with the Soviet Venus probe.

Embassy officials said the contact was resumed some time prior to March 16. They said no further information was available.

In Britain, Prof. Bernard Lovell, head of the Jodrell Bank radio observatory, told U.S. officials he had received no indication from the Soviets that contact has been resumed. He said the Soviets in early March discontinued any notifications to him about the probe.

## Venus Radar-Bounced

The 85-ft. dish antenna at Goldstone, Calif., has made contact with Venus.

The station, operated by Jet Propulsion Laboratory for NASA, bounced radar signals off the planet on a frequency of 2388 mc, beginning March 10.

The radar reflections are a series of experiments designed to determine whether the planet spins and, if so, the speed and orientation of spin, as well as the nature of Venus' reflectivity and an exact measurement of the astronomical unit. The experiments will continue through April 11, the date that earth and Venus come closest.

JPL used a maser and a parametric amplifier. Radar signals have been bounced off Venus in the past, but this is the first time the reflected signal—6 and ½ min. after transmission—was detected without elaborate processing and analysis.

## Life Signs from Old Stone

Advanced techniques of meteorite analysis have prompted scientists to conclude that a century-old meteorite came from a place where life existed.

The stony fragment, which impacted near Orgueil, France, May 14, 1864, was subjected to infrared and ultraviolet spectroscopy, X-ray diffraction and high-molecular-weight mass spectroscopy. Scientists Bartholomew Nagy, Douglas J. Hennessy of Fordham University, and Warren G. Meinschein of Esso R&E Co. detected certain hydrocarbons similar to those occurring in earth living matter.

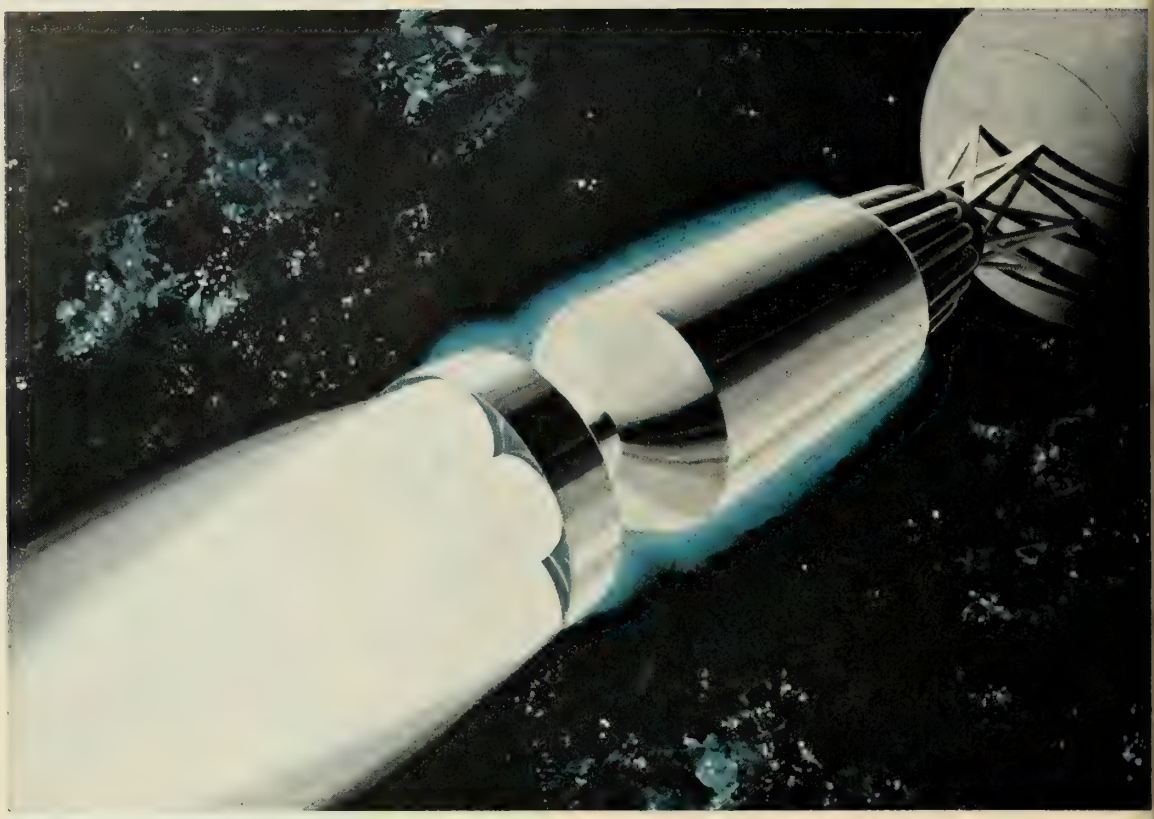







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# NUCLEAR ROCKET PROPULSION AT AEROJET-GENERAL



Nuclear rockets, with a performance capability nearly twice that of the highest-specific-impulse chemical rockets, have been of major interest to Aerojet-General for several years.

Exploratory studies were initiated by Aerojet in 1955 to ascertain the feasibility of nuclear rockets, and the technical advances required to develop a successful nuclear propulsion system were determined. This work at Aerojet has undergone continuous expansion under government and company sponsored programs. Included are: preliminary design of engines and vehicles, simulated nuclear engine tests, radiation hazards research, analog computer system design (to simulate nuclear rocket operation), nuclear test facility construction, and the design, development, testing, and manufacture of reactors.

***These programs have resulted in significant progress toward the development of a practical and reliable nuclear propulsion system. They are based on Aerojet's combined experience in liquid and solid propellant rocketry, nuclear technology, and cryogenics—experience which ensures that the challenge of a new era in propulsion can, and will, be met.***

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THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

# The Countdown

## WASHINGTON

### Cutting Up the Missile Dollar

Breakout of FY '62 budget shows the Navy will spend $193 million on *Polaris* missile procurement, $396 million on *Polaris* missile RDT&E, and $704 million on FBM subs. Only $200 is in the budget for *Atlas* to complete the program, while there is $350 million toward the "full financing" of *Titan*. *Minuteman* is on an incremental financing basis. Total new obligational authority for the Air Force to procure missiles of all varieties is $2.8 billion—including a $100-million buy-out of *Hound Dogs* and $67 million to complete *Thor*, *Jupiter* and *Bomarc* funding.

### No More Bread on Water

One of the hard-to-take effects of the DOD order giving the Air Force its head in space will be a clamp-down on speculative spending by the Navy and Army. Almost certain to suffer will be the ambitious plans for the Navy's Pacific Missile Range. Some insiders won't be surprised if the AF annexes PMR Point Arguello, which abuts Vandenberg AFB.

### NASA vs. AF

Showdown on who will take charge of the U.S. man-in-space program—and with it the main role of space exploration—will come soon before President Kennedy's National Aeronautics and Space Council. Cost is almost certain to rule out any duplicating programs, so it comes down to a choice between the Air Force and NASA. Best bet on who'll win when the cards are dealt: the Air Force.

### Scouts for Hydra

Navy has ordered six *Scout* rockets from NASA for use in its Project *Hydra* at PMR, to prove the feasibility of firing large solid boosters as they float in the sea. First shot will be with *Scout* which was damaged.

### Combat' Polaris Shots

FBM sub Theodore Roosevelt, now at Cape Canaveral, may be the first to try simulated combat shots with *Polaris*. Four *Polaris* missiles carrying 400 lbs. of HE explosive in a non-nuclear warhead are scheduled for firing soon at full range.

### Next Big Shakeup?

If DOD Secretary McNamara remains consistent in re-shaping the missions of the services, he could be thinking of transferring the Air Force's Tactical Air Command and possibly MATS to the Army—which needs them both to increase its limited war strike power.

### On the Pad

NASA's *S-15* cosmic-ray telescope satellite—next-to last in the *Juno II* program—is set to go from Canaveral in the next few days.

## INDUSTRY

### Titan I Has Valve Problems

Several failures of a hydraulic flow control valve in the *Titan I* fueling system are being attributed to deficiency in non-destructive testing methods. "Not frequent, but costly," the failures have occurred despite adherence to standard tests—including ladle samples, break specimens, periodic physical and chemical analysis of molten metal.

### Lockheed Wins AUTEC Contract

Surprise winner of a six-month Navy study contract for $372,000 to devise a plan for developing the proposed Atlantic Underwater Test & Evaluation Center (AUTEC) is Lockheed-Burbank. Award gives Lockheed the inside track on the range, which the Navy expects to cost $100 million.

### East vs. West

Southern California groups are fighting off new attempts by East Coast interests to rope off more defense contracts. Los Angeles leaders are dead set against the Kennedy Administration's line of thinking that contracts should be channelled willy-nilly to depressed areas regardless of their ability to produce quality merchandise.

### R&D Intelligence

Aerospace Corp.'s Leo Gatzek sees improvements on the way in development of "superalloys" from refractory metals, composites, plastics, metal fabrics . . . NASA is studying the possibility of keeping at least one *Tiros* weather satellite in orbit until the first *Nimbus* is ready in late 1962 . . . Industry is turning to the electron beam microanalyzer to select materials for missiles and space vehicles . . . NASA will build a new launch stand at Cape Canaveral to take care of all *Atlas-Agena B*, *Centaur* and *Mercury* shots for the next few years.

## INTERNATIONAL

### British Sounding Rockets

Regular weekly launchings of sounding rockets to a 37-mi. height are being scheduled by the British. Shots from near Aberporth, Wales, and South Uist, Scotland, will take meteorological readings.

### Overseas Pipeline

Russian air defense brass hats are said to be worried about licking the electronic countermeasures problem in countering U.S. satellite and *Dyna-Soar* flights over their territory . . . United Electrodynamics of Pasadena, Calif., will work with SAAB on the telemetry instrumentation of a new Swedish missile test site . . . On its arrival at Holy Loch, Scotland, the Patrick Henry FBM sub had to replace one of its *Polaris* missiles because of a flight control system problem. It got a replacement from the tender Proteus.

# Army Ready to Buy Entac

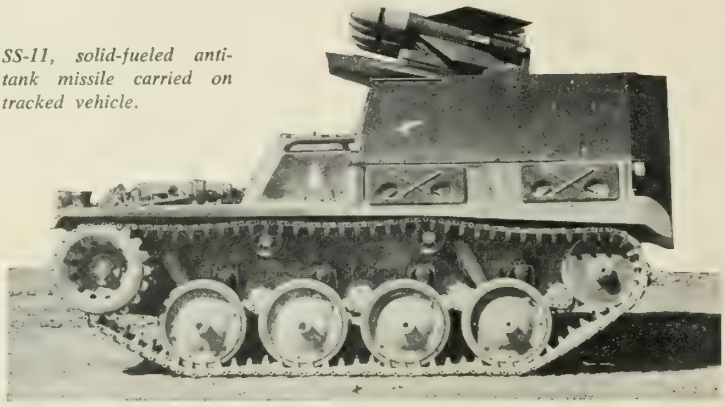
## *First Large-Scale Purchase Abroad by U.S.*

***More than $20 million worth of French antitank missiles to be procured during FY 1961, more in FY '62; U.S. manufacturers expected to protest outcome of long competition as drain on gold; Army also said to be acquiring French SS-11's***

**by William E. Howard**

THE UNITED STATES is understood to be preparing to make its first large-scale buy of foreign-made missiles.

MISSILES AND ROCKETS has learned the Army is planning to purchase in excess of $20 million worth of *Entac* light antitank missiles from France before the end of FY '61. This is to be followed up by another buy in FY '62.



*SS-11, solid-fueled antitank missile carried on tracked vehicle.*

Moreover, the Army is understood to be in the process of acquiring a "substantial" number of the longer-range *SS-11* antitank missile, also from France. Both missiles are being produced by Nord Aviation.

Over the next five years—as the Army moves to beef-up its limited war forces—expenditures for both missiles, industry sources believe, could run "into the tens of millions."

The first *Entacs* would be bought out of a $45-million unexpended add-on to the FY '61 budget.

The decision to go abroad for antitank missiles is expected to generate loud protests from the American defense industry and touch off another uproar over the drain on U.S. gold reserves. "You can't justify going against the gold policy," one missile industry official told M/R, "when equally good antitank missiles can be produced in the States."

Army officials have been debating the antitank missile issue for more than a year, and the competition has been bitter. While some U.S. manufacturers have entered proposals, the contest has been mostly between foreign missiles.

• **Highly efficient**—*Entac* was the "sleeper" in the race.

It is described as "lighter and cheaper and more efficient" than the *SS-10* which has been purchased in limited quantities by the U.S. Army for deployment on helicopters and jeeps.

*Entac* carries a HE warhead in a shaped charge. Its range is about 6600 ft. Overall weight with container is 80 lbs., launch weight is 37 lbs. and flight weight is 26 lbs. Like most other antitank missiles, it is wire-guided and intended for use by a single infantryman.

The *SS-11* has a range of 1650 to 11,500 ft. and is deployed aboard armored vehicles (see photo.) By contrast to the *Entac* the *SS-11* has a launch weight of 62 lbs. Both are solid-fueled.

In recent weeks, the competition reportedly was narrowed to the *Entac*, Britain's Vickers-Armstrong Ltd. *Vigilant* and the *Cobra*, made jointly by Boelkow Entwicklungen of Germany and Daystrom Inc. of the U.S. A spokesman for Daystrom indicated that if the *Cobra* had been chosen, it would have been produced largely in the United States.

It is understood that the *Cobra*, which has a 20.2 lbs. launch weight and an effective range of 5280 ft., had proven out well in trials conducted last year in Germany b the U.S. Seventh Army. However during more tests a Redstone Arsenal i Alabama, severa units exploded o launch.

The Daystron spokesman tol M/R that for th Redstone tests th Army had sprayed the fibreglass *Cobr* launcher case wit a paint that acte as a solvent. Whe the missiles wer fired, they ignite the paint and the explosions followed

General Electric Co. has a licensing arrangement with Nord Aviation t produce both *SS-10* and *SS-11* mis siles. It was reported, however, tha the quantity of *SS-11's* needed initiall by the Army would not be sufficient t warrant starting a production line i this country.

• **Boost for France**—Procuremen of the *SS-11* by the United States i in line with a general move by Nort Atlantic Treaty Organization countrie to standardize on this missile. Th movement was started last year b Germany, which ordered several mi lion dollars worth of *SS-11's*.

The French missile industry—a ready in the throes of expansion—would be helped considerably by th contemplated U.S. buy. Militar sources say production facilities fo *Entac* are available and that they coul be turned out in quantity in a sho period of time. Based on a unit pric of $1000-$1200, the initial purchas could total around 17,000 *Entacs*.

While *Entac* has won the first roun in the great anti-tank missile compet tion, the U.S. Army is known to b looking for a still lighter and cheape weapon to equip infantrymen.

# U.S. Seeks To Set Firm Space Policy Objectives

## *Welsh chosen for Council; AF revises command; Army, Navy smart under directive*

THE ADMINISTRATION is beginning this week to map the nation's new space exploration program—after narrowing the "roles and missions" field to NASA and the Air Force.

Just how big a space effort will be undertaken—and by whom—will be influenced by the high-policy-making National Aeronautics and Space Council.

Perhaps significantly, the Council will have as its chief officer the former legislative assistant to Sen. Stuart Symington, who is former Air Force secretary and strong advocate of a large military space program.

Dr. Edward C. Welsh, 57, was appointed executive secretary of the Council last week, ending at least for the time being congressional complaints that Kennedy had dragged his feet on organizing the agency. The president had promised in January to use the Council—long dormant under the Eisenhower Administration—to chart a course to overtake Russia in space.

How swiftly the Council, which is headed by Vice President Johnson, will move is a question. It is almost certain to order a massive review of the entire space program—military and civilian—which could take weeks or months.

The big problem before the Council is to set down some hard and fast objectives—objectives which Kennedy must buy or reject in the FY '62 budget and succeeding budgets.

In other developments:

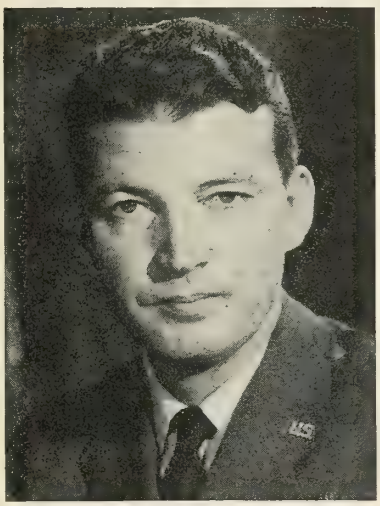
–The Air Force ordered a major shakeup of its fiscal and development commands, placing Lt. Gen. Bernard A. Schriever at the head of a new Air Force Systems Command (AFSC)—which will replace Schriever's old Air Research and Development Command as of July 1.

–Both the Army and Navy indicated their displeasure to Congress at being virtually read out of space under the new directive (M/R, March 13, p. 16) renewing the Air Force's license as the main military space agency.

• **Cannibalizing Denied**—Hearings before the House Space Committee brought out that Defense Secretary McNamara had bypassed the Joint Chiefs of Staff (headed by Army Gen. Lyman Lemnitzer) in issuing the space directive to the Air Force. The hearings also produced a disclaimer by Air Force Chief of Staff Thomas D. White that the Air Force was seeking to cannibalize NASA.

"Absolutely not," replied White when asked the question.

"I know of no one in the Air Force who holds the view that NASA should be combined with the Air Force. The job is plenty big for all of us. Relations between the Air Force and NASA have never been better."



**Lt. Gen. Bernard A. Schriever**
*Heads new Air Force Command.*

White conceded, however, that he did write a memorandum last April which said NASA "will play a large part in the national effort and inevitably will be closely associated if not eventually combined with the military." By way of explanation, White said he was only stating a conceivable possibility at the time—not advocating it.

White and McNamara also tried to calm Army and Navy fears that their space projects would be safe, along with possession of the *Nike-Zeus* and *Polaris* programs. But they didn't quite succeed. Just how high feelings were running during the hearings was made clear by the Army's R&D chief, Lt. Gen. Arthur G. Trudeau, who cracked that if the Air Force didn't become a "space force" it would be "only the silent silo sitters of the seventies."

In another comment which he later recanted, Trudeau made what appeared to be a slap at McNamara:

"We read every day about how fortunate we are to have the civilian competency which is being brought into the government and as a simple military man I accept these profound decisions as being made with great wisdom."

• **New AF Commands**—But, if the military was unhappy, contractors at least were given something to look forward to in the Air Force reorganization of ARDC. The objectives of the new command setup will be to greatly simplify and streamline lines of authority in development of missile and space systems. Here's how it works:

Schriever's new AFSC will have sole responsibility for acquisition and development of missiles and space systems—including contracting and funding—right straight through the time they are turned over to the user command. Headquarters will remain at Andrews AFB, Md., where ARDC is presently located, and Schriever's command will take over 30-40% of the funds previously handled by the Air Materiel Command.

AMC, headquartered at Wright-Patterson AFB, Ohio, has been renamed the Air Force Logistic Command (AFLC) and will continue under the direction of Gen. Samuel E. Anderson as the logistic support agency of the entire Air Force.

All basic and applied research formerly under various offices of ARDC has been consolidated under the new Office of Aerospace Research. It will be headed by Maj. Gen. David E. Hooks, who will report directly to headquarters USAF in the Pentagon. This is the only function being removed from Schriever's new command.

AMC's Ballistic Missile Center and ARDC's Ballistic Missiles Division are being combined and realigned as two of four new divisions under AFSC: Space Systems Division, headed by Maj. Gen. Osmond J. Ritland, and Ballistic Systems Division by Maj. Gen. Thomas P. Gerrity. The other divisions are Aeronautical Systems Division at Wright-Patterson, retaining management of the *Dyna-Soar* program; and Electronics Systems Division at Cambridge, Mass., combining the functions of CCDD and ESC.

One of the prime targets of the reorganization is speeding up ICBM base construction. Brig. Gen. A. C. Welling of the Army Corps of Engineers, who had functioned as an equal to Gerrity, now will become his deputy, giving Gerrity direct authority from ICBM production to base completion. ⌗

*Not in present plans . . .*

# Atlas-G Boosters Await Go-ahead

***Convair says new types with Rocketdyne H-2 engines and Centaur 2nd stages offer up to 660,000 lbs. thrust***

**by Richard van Osten**

ATLAS-G SPACE boosters could be available in about 20 months if a go-ahead were given now, according to Convair-Astronautics.

Two versions of the *Atlas-G* have been proposed to Air Force and National Aeronautics and Space Administration, but no procurement has been proposed in current planning.

*Atlas-G* could be furnished in a 250,000-lb.-thrust configuration *(G-250)* or a 300,000-lb.-thrust model *(G-300)*. Actually, there would be four *Atlas-G* types—the two basic boosters plus the same boosters with a *Centaur* second stage.

Based upon a five-year "ultimate" development program, Convair believes the *"G"* could place one payload pound in orbit for $100 if *Centaur* were used as the second stage.

Another cost factor of *Atlas-G* is that the basic vehicle could be built with existing techniques, tooling and materials used for earlier *Atlas* models.

The *"G"* has a 10-ft. diameter, same as other models. Its overall length is increased for greater fuel capacity—with *Centaur* and adapter hardware, overall length would be about 135 ft. Other than the increased length, the *"G"'s* external appearance is identical to *"E"* or *"F"* models to the untrained eye.

Minimum skin thickness would be increased between 0.012 and 0.015 in. over present skin gauges, and internal pressurization would be upped slightly to handle the greater payloads.

If full advantage is taken of all present facilities for *Atlas* production, plus existing know-how, *"G"* development costs are estimated at about $100 million, all-inclusive. This figure includes the fabrication and test of four developmental models, all flight tests and the slight modifications to standard *Atlas* launch pads to accommodate the *"G"* models.

The *G-250* with *Centaur* would weigh about 432,000 lbs. when loaded with RP-1, and LOX conventional *Atlas* propellant. No special fuels are planned for the *"G"* at this time, although the missile and powerplant components are easily adaptable for storable fuels. The *G-300* would weigh slightly more, about 440,000 lbs., and has a thrust/weight ratio of 1.33:1.

Both the *G-250* and *G-300* would use Rocketdyne's H-2 engine as boosters. Present Rocketdyne-built *Atlas* sustainer of about 60,000-lbs. thrust would not be changed for the *"G."*

Total boost thrust with both boosters and the sustainer operating is about 560,000 lbs. for the *G-250* and 660,000 lbs. for the *G-300*. With *Centaur* as second stage, the *G-250* version could place 18,000 lbs. in a 300-n.-mi. orbit or 3500 lbs. in a "24-hr." orbit. The *G-300*, also with *Centaur*, could lift 20,000 lbs. into a 300-n.-mi. orbit and put 4000 lbs. in a 24-hr. orbit.

Without *Centaur* both the *G-250* and *G-300* vehicles could boost about four tons into a 300-n.-mi. orbit.

Rocketdyne's H-2 engine is, in many ways, a growth version of the H-1 just as the *Atlas-G* is a growth of the *"E"*. Development of the H-2 got under way about the same time as the H-1 development began for *Saturn*. Some funding came from NASA on the basis of a feasibility study for a follow-on engine to replace *Saturn's* H-1 engine if needed. The H-2 was designed to fit the *Saturn* envelope but up-rated to 250,000 and 300,000 lbs. thrust. Some development funding came also from the Air Force. NASA has expressed continued interest in the H-2 engine, but no funding has yet been made available.

• **Simplicity**—The H-2 is another cost-cutting component. For one, it is even simpler than the H-1 and carries further developments proven on Rocketdyne's X-1 engine.

Thrust chamber design will probably follow that of the H-1 engine which has been operated, as far as the thrust chambers are concerned, at levels as high as 270,000 lbs. The H-2's turbopump is designed to handle storable propellants and the thrust chambers have been tested with storables.

One major switch from the H-1 would be the method of turbopump drive. If the H-2/*Atlas-G* combination vehicle is used is a mission that may require some degree of throttling or speed changes, the turbopump will probably be a direct-drive type—more or less a scaled-down version of the pump used on the F-1 1.5-million-lb.-thrust engine.

If the mission requires fixed, precisely calibrated engine operation, the H-2 turbopump would most likely be driven by a gas tap-off system from the turbine chamber. This concept has been successfully tested in over 100 test stand runs.

Like the *Atlas-G*, the H-2 is a "concept," not complete hardware at the present time. It could mesh with the whole *Atlas-G* program in about 18 months, Rocketdyne engineers say. Some tooling for the pumps is available. Technical know-how for control valves and thrust chambers is already well advanced.

Entire H-2 engine system would run higher pressures and flow rates. Specific impulse would be "greatly improved," but Rocketdyne engineers say only that it is greater than 250.

Neither Convair-Astronautics nor Rocketdyne are willing to discuss the *Atlas-G* in great detail as far as possible payloads are concerned.

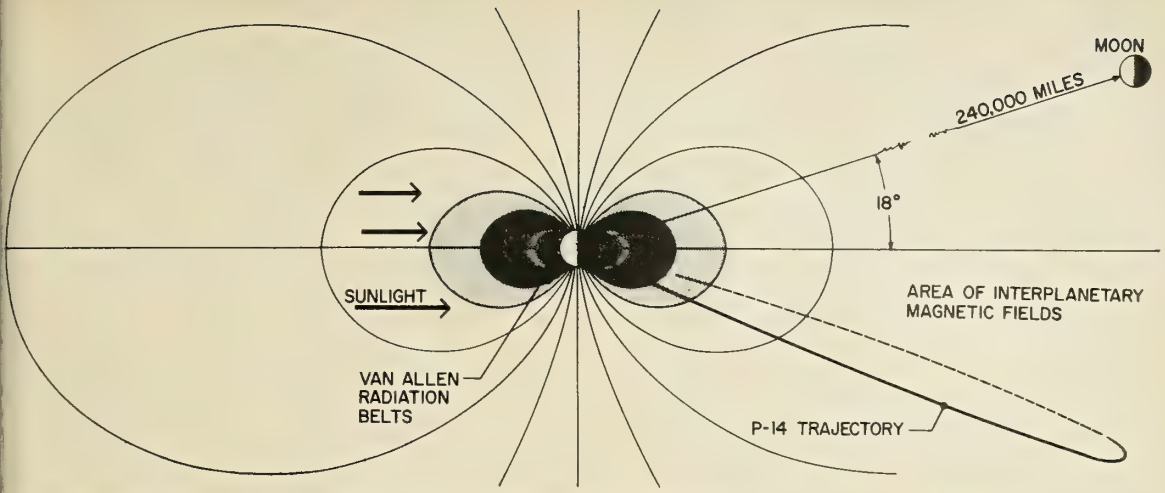
• **Too much range?**—It might be used as a weapon, but as one Convair engineer says, "it would have almost infinite range and what good would it be?"

The *Atlas-G* has been designed for space booster use. It has the most performance of any present booster except *Saturn*, Convair says. The company also believes the *"G"* is attractive for various lunar payloads, military space missions, or *Venus* payloads. The *"G"* has about three times the capability of *Atlas-D* with *Centaur* for injecting payloads into a 24-hr. orbit.

But there is no planned requirement for the *"G."* Convair has no funding to continue studies, and the project is in "limbo" at the moment, the company says.

One Convair spokesman says a prime reason for the *Atlas-G* exclusion from present space programs is that its payload capability to lift payloads is greater than needed for the time period of planned missions. But he also points out that excess payload capability is something "that seldom goes to waste."

The company is keeping the *"G"* on tap, however, in event it is needed for some mission, some scientific project, that's not known at the moment or is unforeseen in planned programs. ⌘




*TRAJECTORY OF P-14 carries it out through the Van Allen belts, away from the sun and in the general direction of the moon.*

# P-14 Ready for Deep-Space Debut

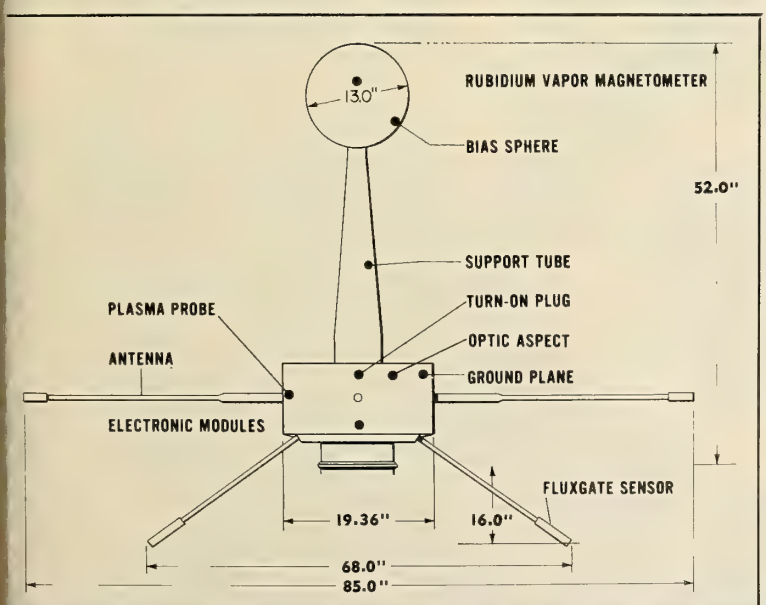
FIRST MAJOR attempt to map the fine details of the magnetic field in cislunar space was being prepared for launching last weekend. A *Delta* vehicle was ready at Cape Canaveral to launch the *P-14* magnetometer probe to an apogee of more than 100,000 miles—possibly as far as 140,000 miles (M/R Jan. 16, p. 14).

The 78-lb. spacecraft carries 168 Yardney silver-zinc cells, providing 18 watts for upwards of 55 hours—enough to power the spacecraft out to apogee and a little beyond. If it follows a perfect trajectory, the four-day flight will carry *P-14* back to a perigee of 105 miles and a further swing out into deep space. However, the batteries may have burned out by that time, in which case it will be impossible to track.

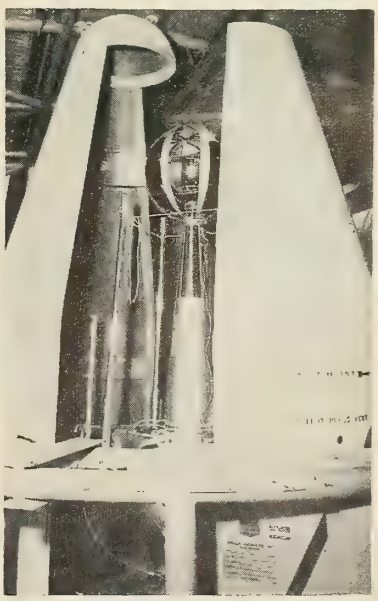
The National Aeronautics and Space Administration said the flight was the first of many in deep space for the rubidium vapor magnetometer, sensitive to field as weak as .01 gamma. Similar experiments will be aboard the *Ranger* deep space and lunar landing flights.

The spacecraft also carried two fluxgate magnetometers, sensitive to fields between 0.5 and 25 gammas for determining the direction of weak fields. All the magnetometer experiments were developed by NASA's Goddard Space Flight Center.

An experiment to measure density, direction and bulk velocity of low-energy plasma—protons in the 120 ev-2.5 kv range—was designed by MIT. An optical aspect sensor was prepared by Goddard SFC. ⁂




*ENGINEERING LAYOUT of spacecraft shows magnetometer on a small sphere at the end of rod extending from main body, which carries 168 silver-zinc cells.*



*P-14 sits atop final stage of Delta, with antennas folded inside fairing halves.*

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# accurate
# attack

Today's pilots traveling at supersonic speeds must seek out targets they cannot see. To make low-level attacks in any weather, day or night, requires highly sophisticated electronic aids. Autonetics meets this need with advanced radars using terrain avoidance equipment, bombing-navigation systems and projected displays. Such are: NASARR, a compact, lightweight, monopulse radar system in F-105's of the USAF, the F-104's of Canada, West Germany, Belgium, Netherlands and Japan; and the AN/ASB-12 radar-equipped, inertial bomb-nav system in the Navy's Mach 2 A3J.

Electromechanical systems by **Autonetics** Division of North American Aviation



# Technical Countdown

## ADVANCED MATERIALS

### Powerful New Oxidizer—Oxozone Fluoride

Chemists at the Temple University Research Institute have formed $O_4F_2$ (Oxozone fluoride) through an electrical discharge at low temperatures in an atmosphere of 2 moles $O_2$ to 1 mole $F_2$. The fluoride is a reddish-brown solid, sometimes forming needle-like clusters. Bond strength studies on the substance indicate the possibility of forming the higher members $O_5F_2$ and $O_6F_2$. A new form of oxygen, cyclic $O_5$ or $O_6$ polymer may be capable of existence.

### Russians Cold Roll Titanium from Powder

Titanium strip exhibiting a tensile strength of 67.5 kg/mm² and an elongation of 23.7% is the result of a process which starts with rolled, raw-powder strip 1 mm thick. A series of sintering and rolling operations produces the final strip thickness of 0.45 mm. The process originated at the Gor'kiy Polytechnic Institute, USSR.

### Large Space Chamber at Goddard

NASA's Goddard Space Flight Center is running final acceptance tests on an 8-by-8-ft. Stokes thermal vacuum chamber with Microvac pumps capable of achieving $10^{-8}$ mm Hg vacuum and varying temperature from −65° to +100°C.

## ELECTRONICS

### PSMR Program To Affect Manufacturers

Recommendations of the recently completed PSMR (Parts Specifications Management for Reliability) report will have tremendous impact on the electronics industry. Already being put into effect by DOD, the program will increase costs because it calls for more testing and tighter manufacture controls. Some of the higher costs may be offset by increased yields, however, according to Paul Darnell, chairman of the 56-man military-industry study group which prepared the report.

### Rocket Trails for Antennas

The use of rocket and jet exhaust gases as low- and medium-frequency radio antennas for intra-space communication has been proposed by International Telephone and Telegraph Corp. ITT has been studying the feasibility of ionized gas trails as r-f radiators under an Office of Naval Research contract.

### Pershing Guidance Touted

*Pershing* all-inertial guidance has been claimed an unqualified success by Army following the latest (March 14) flight from Cape Canaveral. Using 1-degree-of-freedom air-bearing gyros, the new system was developed by Army Ballistic Missile Agency, Redstone Arsenal, built by Bendix-Eclipse Pioneer Division, Teterboro, N.J., and is believed considerably more accurate than either *Jupiter* or *Redstone*, which employ similar guidance.

### Heavy Nuclei Caught in Cajun Tests

Heavy nuclei—carbon, nitrogen and oxygen—have been found in the clouds of particles spewed out during the major solar flare last November. During the solar event, NASA launched seven *Nike-Cajun* sounding rockets to 90 miles altitude from Ft. Churchill with nuclear emulsion packages. Five were recovered, providing the first evidence of heavy nuclei in the lower ionosphere.

### British to Help Instrument S-51

Britain's instrumentation for the *S-51* ionosphere satellite, to be launched by a *Scout* next winter, includes two electron temperature gauges, a positive ion mass gauge, three Lyman alpha channels, two X-ray counters, a solar-aspect sensor, a cosmic-ray detector and an electron-density detector.

### Diode Reliability Soars

Failure of only one diode in 150 million hours of diode operation is reported by Pacific Semiconductors, Inc. Produced for American Bosch Arma's *Atlas* inertial guidance package, the diodes turned up a failure rate of 0.0015%/1000 hours based on a 90% confidence level.

## OPTICS

### IR Terrain Analyses Studied

Infrared spectrophotometers may be used for topographic and geologic mapping, says Perkin-Elmer Corp. Use of such airborne instruments, responsive to wavelengths in the 0.25 to 5-micron range, is now under feasibility study by the company for Army Engineers in Vicksburg as a means to determine terrain structure and suitability for travel by heavy military vehicles. Study involves correlation of diffuse IR reflectance characteristics and terrain—soil types and condition, slope, moisture, vegetation.

## SUPPORT EQUIPMENT

### FBM Fire Control Funds Upped 65%

Program for the advanced *Polaris* fire control system was vitaminized last week. Contract funds to GE's Pittsfield Ordnance Dept. were increased by Navy from $34 million to over $54 million. The new Mk84 system, having vastly increased operational capability and flexibility, will be installed first in the new *Polaris* sub USS Lafayette (SSBN-616). System uses new digital computer techniques and is more automatic than its Mk80 predecessor.

## PROPULSION

### New Booster Proposal

Thiokol estimates that development of a one-piece solid motor of 3 million lbs. thrust, 14 ft. in diameter, would take about three years. An overall vehicle, clustering seven such motors, could be ready for manned flights in five years, the company said in a report on a NASA study last week. Burning time was not specified, but Thiokol said the cluster would propel more than 300,000 lbs. to orbital velocity or more than 125,000 lbs. to escape velocity.

### Hula Hoop Helps Hawk

Aerojet-General Corp. is using a modified hula hoop to aid in production of the Army's *Hawk* surface-to-air missile motor. Production requires that portions of the propellant liner be bonded to the case while other portions remain free. A problem in sealing one area off from the other was solved through use of a flexible plastic hoop which forms a "dam" between the two areas.

# A Study in Near-Chaos

## Wire/Cable Problems Cry for Solution

***Lack of standards, lead-time and design concurrency, poor intra-industry cooperation, and chemical difficulties bedevil a critical aspect of missilery; growing awareness in industry and military is bringing improvement—but at slow pace.***

**by Hal Gettings**

DELAYS, HIGHER COSTS, and even launch failures hitting U.S. missile programs are being attributed to critical deficiencies in wiring and cabling.

A MISSILES AND ROCKETS survey finds many industry experts feel the cure for these deficiencies may be on the way but it is too slow in coming.

The military is deeply concerned. Many missilemen are aware of the adverse effect of wire and cable shortcomings on previous missile programs —and the necessity for heading off serious trouble in future programs.

Because of this growing awareness, considerable progress has been made in the past year. Probably the most significant achievement is the broadened scope of the one good, general, ground-wire and cable specification—MIL-C-13777—and its acceptance by all military services.

But "Triple-7"—as it's known in the trade—is no cure-all specification. Depending on whom you talk to, its value ranges from zero to near-perfect. Neither missile primes, the military, nor the wire and cable manufacturers agree on its usefulness or on how it can best be improved.

Another serious lack is in lead-time and design concurrency. Cable manufacturers want to be in at the planning stage of a missile system. Only then, they say, can they turn out a product that will do a satisfactory job at a reasonable cost—and be ready when it's needed.

Examples of this lack are many. Early *Polaris* missiles flew with some of the cabling carried on the exterior of the bird. Some of the first designs made no allowance for the interconnecting wiring.



*FAULTY UMBILICAL disconnect (see circle) caused failure of this Atlas-Agena vehicle to orbit a Samos satellite.*

*Thor* installations in England were held up for several weeks waiting for ground cables.

Industry spokesmen recall several instances where R&D programs were delayed for days or even weeks because of troubles with inadequate or poorly-designed cabling.

Troubles have also arisen from poor coordination and cooperation between wire and cable manufacturers and connector manufacturers.

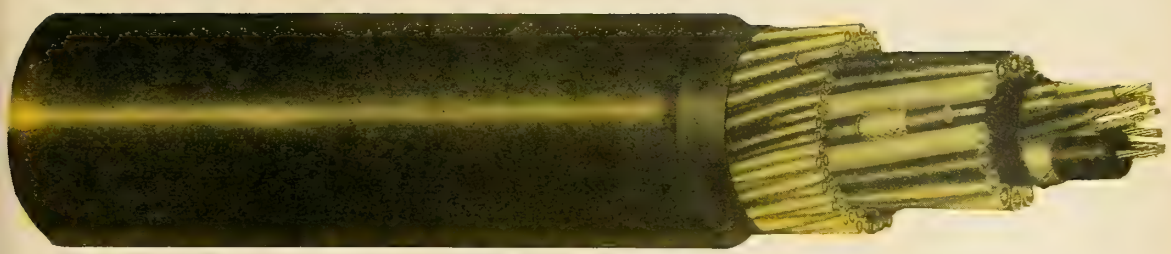
Many concerned with the problem have suggestions for improvement, but none has a pat answer. All agree that more lead time, design concurrency, standardization, and better specifications would help.

The solution will be difficult at best. Bitter fights have evolved over changing specifications. It is sometimes alleged that companies whose manufacturing processes are included in existing specifications in such a way as to give them a competitive edge strongly resist any change.

Proponents of various materials, jealous of their favorites, adamantly oppose the introduction of new materials, with the result that acceptance and standardization of new materials and processes usually trails far behind the state of the art.

Many other factors contribute to the situation. Cable people say that many of those responsible for specifying and buying wire and cable are not trained for the task. They must be technically competent to be able to keep up with developments and judge the characteristics of available products against their requirements. And there are few guidelines to help them.

In the first place, requirements are often poorly defined. Secondly, standards and specifications are often so loosely spelled out that there is no yardstick for determining the merit



*TYPICAL MISSILE UMBILICAL cable is complex assembly of r-f coaxial, power, data, and control conductors. Designers must consider problems of crosstalk, temperature distribution, flexibility, strength, and material compatability.*

of the various products on the market. Even basic methods of measuring the mechanical properties—modulus of elasticity, abrasion resistance, flammability, cold flow, etc.—of wire and cable components are unstandardized and subject to disagreement. Consequently, data are often uncorrelatable and virtually unusable. The buyer is left in the middle with no place to go.

Often, too, buyers have pets of their own. A man enamored of polyvinyl insulation, for instance, may be hard to convince that some other material might better fit a particular application.

Some of the big wire and cable manufacturers admit that they failed at first to appreciate the potential of the missile market. Because they weren't interested in the small-quantity R&D requirements, other sources had to be found. Consequently, small companies sprang up and bred still other companies which went after the "odd" quantities and configurations of missile wire and cable. Many of them, of course, did a good job, and their stepping into the breach at least got the work done.

Frequently, however, lack of experience and proper equipment resulted in poor quality or misapplication that didn't show up until some time after the cable had been installed. Failures resulted, if not immediately, after several weeks or months in service. Not many of these companies survive. A few prospered and grew, but most have disappeared—through bankruptcy or absorption by other organizations.

The very nature of the missile wire and cable business complicates the overall situation. In most cases, the missile prime contractor specifies and buys the cable for his particular system; there is no central coordination of requirements and standards. Arbitrary "parts peculiar" specifications are devised to fit each procurement.

Here, too, the human factor often enters in. There are favored suppliers, configurations and materials. One major W&C manufacturer complained that his office had three legal-size file cabinets full of individual specs and more coming in with every request for bid. As a result, even if an identical cable had been previously designed and built, it was almost impossible to trace back and find it, and the R&D job would have to be done all over again. Too, it is quite likely in many instances that an almost-identical cable had already been built that would do the job. But it would be hard to find it—and even harder to get it approved.

• **Pentagon apathy**—Since the prime contractors usually handle procurement, DOD has shown little interest, at a high level, in setting up standards and specifications. Some time ago, the Department of Commerce (Wire and Cable Product Branch, Business and Defense Services Administration) offered to survey the situation and set up requirements data. But, because of military disinterest, they could not get military requirements—amounts, types, costs, etc.—and, consequently, the survey was never approved.

As mentioned previously, lack of cooperation between wire and cable manufacturers and connector manufacturers is another source of difficulty. Since terminations and connectors make up a large part of total assembly cost, this is an area of extreme importance. W&C people claim that the connector builders jealously guard proprietary design data on their products to such an extent that it's hard to know exactly what's available and what they should buy.

Also, the lack of standards and specs in this area means that receptacles and plugs must be built by the same manufacturer. Once a connector unit is installed in a missile, any further orders for replacement and spares must specify that particular manufacturer's product and he becomes virtually sole source from then on.

Another point of complaint by some connector manufacturers centers about the "second source" agreement often entered into between buyer and supplier. This agreement says, in effect, that the manufacturer will release proprietary rights to the military if they will in turn agree not to seek a second source for the item until it becomes a "standard." Such an agreement effectively precludes another source.

There is no question that sole-sourcing and lack of standardization raises problems and costs money. In one missile application, for instance, to tie together the equipment requires "jumpers on jumpers"—two sets of adapters to mate the different connector configurations.

Some progress is being made in this area, notably in the operational *Atlas* silo cabling. Here, one connector configuration serves about 80% of the system demands for interstage connections. For the remaining 20%, 38 items are made with two basic shell sizes and two basic inserts.

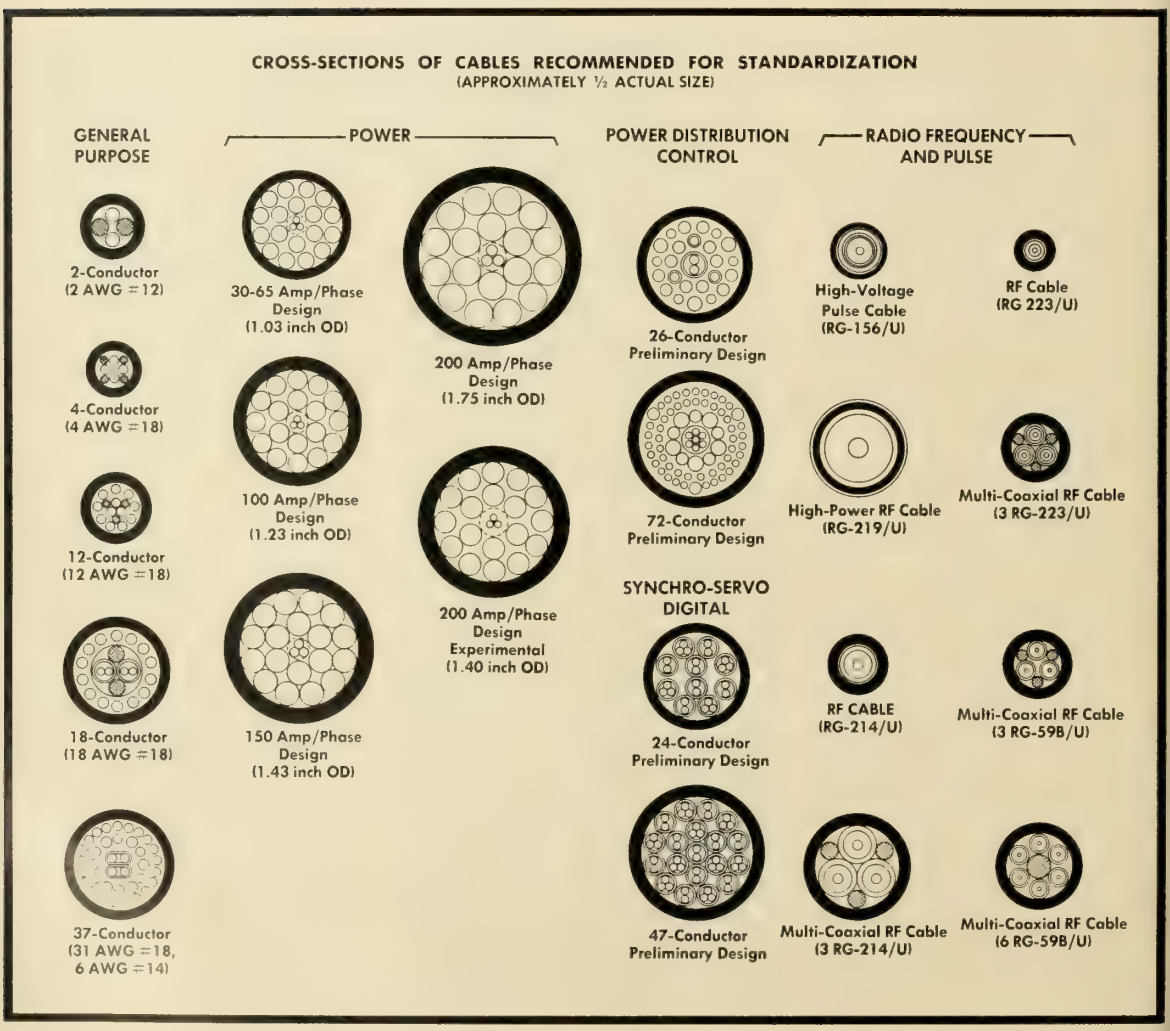
By contrast, there were 16 different configurations on the original *Minuteman* R&D site.

Further, there is sometimes lack of coordination between the missile design engineers and the W&C builder with regard to connector mating. In one instance, a four-gang connector receptacle was installed in a missile, and a molded umbilical cable was fabricated with four terminating plugs to connect

*(Continued on page 32)*

# Army Could Cut Cable, Connecto

***Comprehensive study by RCA shows only 21 standardized types of cable in five categories would meet Army's missile system needs; cable design in R&D phase of missile recommended in report***




*ARMY STUDY SHOWED that practically all ground cable system requirements could be filled by 21 designs grouped in five categories. "Synchro-Servo-Resolver" and "Power Distribution, Control" designs are preliminary; final design may require addition of several other configurations.*

# nventory by Better Than Half

THE NUMBER of cable and connector stock items for Army missile systems can be reduced by more than half, a recently completed four-year study reveals.

Major advances in wire, cable and connector technology are both necessary and feasible, according to the same report, which, although directed at the Army, could no doubt be well applied to other military systems as well.

Conducted by RCA Service Co. for the Army Rocket and Guided Missile Agency and the Signal Corps, the $470,000 study chiefly covered improvement and standardization of cables and connectors for missile ground guidance and control. Its findings were based on examinations of the *Nike, Hawk, Corporal, Lacrosse* and *Redstone* systems; supplementary data were drawn from surveys of *Dart, Sergeant, Bomarc, Snark, Terrier* and *Talos*. It is the most comprehensive study of the subject ever conducted.

The conclusions and recommendations have yet to be implemented. There is some feeling that the scope of the work should be even further extended. Although there is no question of the benefits—and necessity—of standardization, progress is slow and the procedure is cumbersome (see story p. 28).

In any case, the report will be highly valuable to both the military and the cable and connector industry. It may well help to bring some order out of the present near-chaotic situation.

• **Major findings**—One of the major conclusions of the study effort was that the so-called "functionalized approach" to cable system design is workable and is the most promising approach to inter-system standardization of cable system components.

Assuming this approach, it was concluded that, with few exceptions, all ground cable system requirements can be assigned to one of five functionalized application categories:

–Primary power
–Power-distribution, control
–Synchro-servo-resolver
–RF and pulse
–General purpose

Approximately 21 standard configurations of cable—within these five categories—will meet the foreseeable general needs of Army missile systems. On the basis of this standardization and categorization, the study group concluded that the list of required stock items could be cut by better than half.

Another serious problem pinpointed by the study is the lack of a "comprehensive and technically adequate" catalog of currently used cable-assembly components. The report pointed out that such a catalog would do much to reduce the requirement for special items now generated by lack of any central source of information. Not only is there no central catalog, but few manufacturers even adequately catalog their own products. As a consequence, buyers and specifiers find it extremely difficult, if not impossible, to determine what products exist.

The study group also considered the time factor in the implementation of standardization recommendations. Their consensus was that little could be done with presently operational systems: retrofit would be undesirable and unwarranted; disruption of an already organized supply system would also interfere with operational status. But the report did mention that consolidation of stock numbers of existing parts would considerably reduce the number of warehoused items without adversely affecting present missiles.

The biggest gain in improvement would come with a long-range approach. Lessons learned through the study could greatly benefit the design of ground cable systems for future missile systems. Such an approach would also allow for the incorporation of evolutionary design improvements, exploiting new materials and processes as they are developed.

In other words, the approach to cable system design developed by the study should be applied to new missile systems in the R&D phase. Such an approach, the report said, can assure maximum standardization of cable system components, together with significant improvements in system reliability.

• **Action recommended**—The RCA study group recommended several immediate and long-range actions to alleviate some of the wire and cable problems:

–A test-to-failure approach to evaluation testing. This would insure that component reliability data would be objective, with little room for interpretation and the injection of uninformed opinion into the evaluation process.

–A unified source of technical data on the properties of materials suitable for cable and connector application. Lack of such data makes material evaluation and selection difficult, if not impossible. Differences in units and test procedures are especially troublesome.

–A technically adequate and standardized glossary of cable and connector terminology.

–A consolidated and comprehensive cable-system design manual, describing important electrical, mechanical, thermal, and environmental aspects to help in defining application requirements and selecting adequate components.

–Establishment and support of a competent standards engineering team, continually collecting and analyzing cable systems data to maintain development with the state of the art.

• **Problems encountered**—The RCA study team ran head-on into many of the problems that plague missile wire and cable. Mentioned in this report:

–Lack of technically adequate systems data.

–Lack of standardized and technically adequate vocabulary.

–Lack of comprehensive up-to-date single source for cable and connector engineering and design procedures.

–Multiplicity of specifications.

–Lack of catalog information on available components.

–Scarcity of technically adequate

*(Continued on page 27)*

# The Hazards of Incompatible Plasticizers

***Additives can attack each other and damage entire systems; other major materials problems include shortage of technical data, variations in testing and measurements***

by John F. Judge

A UNIQUE FORM of chemical warfare within cable materials reportedly has fouled up one missile program—and could easily snarl others.

Polyvinylchloride, a substance used in many cables, is inherently rigid. Plasticizers have to be added to attain the required flexibility and these additives are not usually compatible with each other.

Thus if two different, incompatible plasticizers are used in one system in contact with each other, they may attack each other with disastrous effects to the system as a whole.

This situation has existed between insulation and filler material in certain applications. Nylon is also attacked by some plasticizers. The additives in Neoprene jackets are not always compatible with the insulation.

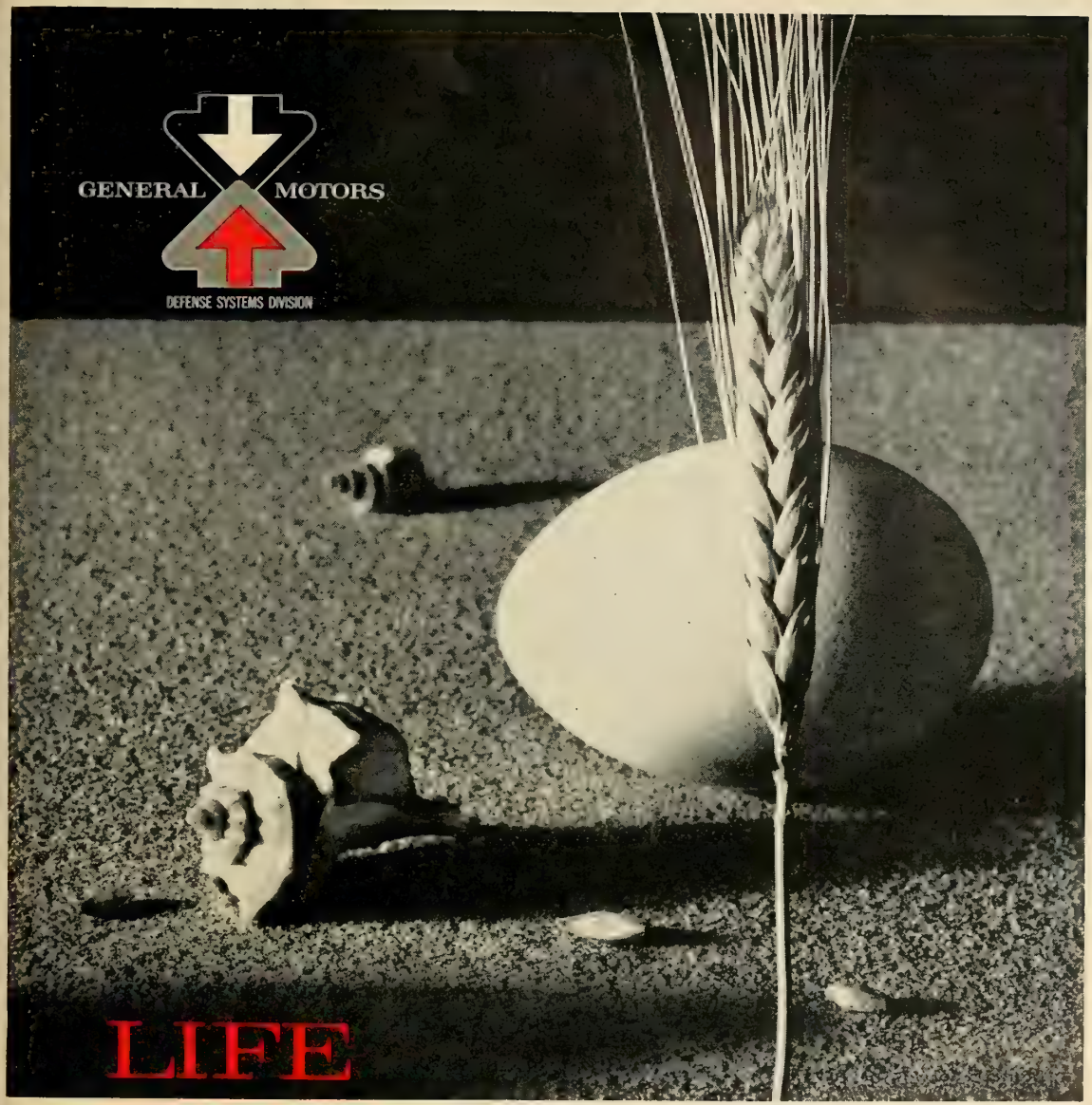
• **Many additives**—Neoprene is a widely used covering material, normally cured in place. To bring the Neoprene curing temperature down low enough to avoid damage to the interior of the cable assembly, certain additives are required.

Others are needed to impart flexibility at low temperatures. These additives can get out of hand—witness

## *Sampling of Some Representative Cable Materials*

| Material | Dielectric Strength (Volts Per Mil) | Typical Material Properties: DC Volume Resistivity (Ohms Per CM) | Dielectric Constant: 60 CPS | Dielectric Constant: Imeg CPS | Cont Operating Temp (Degrees C) | Modulus of Elasticity (PSI x 1000): 25°C | Modulus of Elasticity (PSI x 1000): —55°C | Ozone Resistance | Typical Applications | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| SILICONE RUBBER | 400-800 | $10^{11}$-$10^{15}$ | 3.2 | 3.0 | 175-250 | 1-4 | .5-5 | Good-Excellent | Primary Insulation and Sheath | |
| BUTYL RUBBER | 300-700 | $10^{12}$-$10^{15}$ | 3.8 | 3.5 | 120 | NA | NA | Fair to Good | Primary Insulation and Sheath | |
| LATEX RUBBER | 100 | NA | NA | NA | 60 | NA | NA | Fair | Primary Insulation | |
| NEOPRENE | 80-400 | $10^{10}$ | NA | NA | 90 | .5-.1 | 100 | Good | Sheath | Poor Water Absorp. Characteristics. Excellent Abrasion Resistance |
| "HYPALON" | 100-500 | $10^{11}$ | NA | NA | 85 | 15-60 | 200 | Excellent | Sheath | |
| POLYVINYL-CHLORIDE | 900 | $10^{11}$ | NA | NA | NA | .8 | NA | Good | Sheath | Characteristics Depend Upon Compounding |
| POLYETHY-LENE | 500-900 | $10^{17}$-$10^{18}$ | 2.28 | 2.62 | 120-130 | 12-125 | 100-320 | Fair-Excellent | Primary Insulation and Sheath | Characteristics Depend Upon Density |
| TFE-"TEFLON" | 1100 | $10^{18}$ | 2.1 | 2.1 | 250 | 50-70 | 75-150 | Excellent | Primary Insulation | Ram Extrudable Only In Short Lengths |
| FEP-"TEFLON" | 1500 | $10^{18}$ | 2.1 | 2.1 | 200 | 65 | 150 | Excellent | Primary Insulation | Melt Extrudable |
| "MYLAR" | 4000 | $10^{19}$ | 3.16 | 3.8 | NA | 450-600 | NA | Excellent | Wrap | |
| "KEL-F" | 530-5000 | $10^{16}$ | 2.7 | 2.3 | NA | 200 | NA | Excellent | Primary Insulation | |

NA—Data Not Available




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one case where the effort for flexibility wound up in turning the insulation into a conductor.

But these are not the only materials problems. The Engineering Study performed by RCA Service Co. for the U.S. Army found that a major difficulty involved in the evaluation and engineering application of available materials was the scarcity of adequate technical data.

The differences in test procedures used to derive existing information as well as the differences in units of measurement further confused the picture.

• **Matter of technique**—In the case of selecting cabling construction materials, there are two basic problems. The first is a material evaluation which considers the technical, economic, and strategic feasibility of selecting a given material. The second is the classification of the large number of possible materials in such a manner as to relate their properties to specific design applications.

All cable constructional materials can be evaluated on the above factors, but first there must be a well-defined method of collecting and classifying data related to the materials. This must also relate the properties to the design requirements, and, at the same time, provide an easy, rapid and logical access to the data.

The final selection of cable materials involves consideration of material properties, manufacturing processes, military specifications, and environmental conditions as design criteria.

The Study Group divided the materials into four distinct sections, defined by functional application—electrical conductors, conductor primary insulation, protective outside covering and structural design improvements and fabrication simplification.

The selection of the proper material results from an examination of many different factors, each viewed in terms of relative significance at the time of selection.

For instance, manufacturing factors affect materials evaluation. The rapidity and accuracy attainable in molding or extruding, together with durability, strength, and other attributes make certain materials valuable and favorable to mass production techniques.

Every design requirement of an electrical cable assembly can be related to component material properties. Electrical, thermal, mechanical, environmental and physical properties are significant in the design.

Selecting a material to meet a given set of application requirements demands detailed information concerning each material as well as an appraisal of the material properties. The final selection is made through the usual selection process.

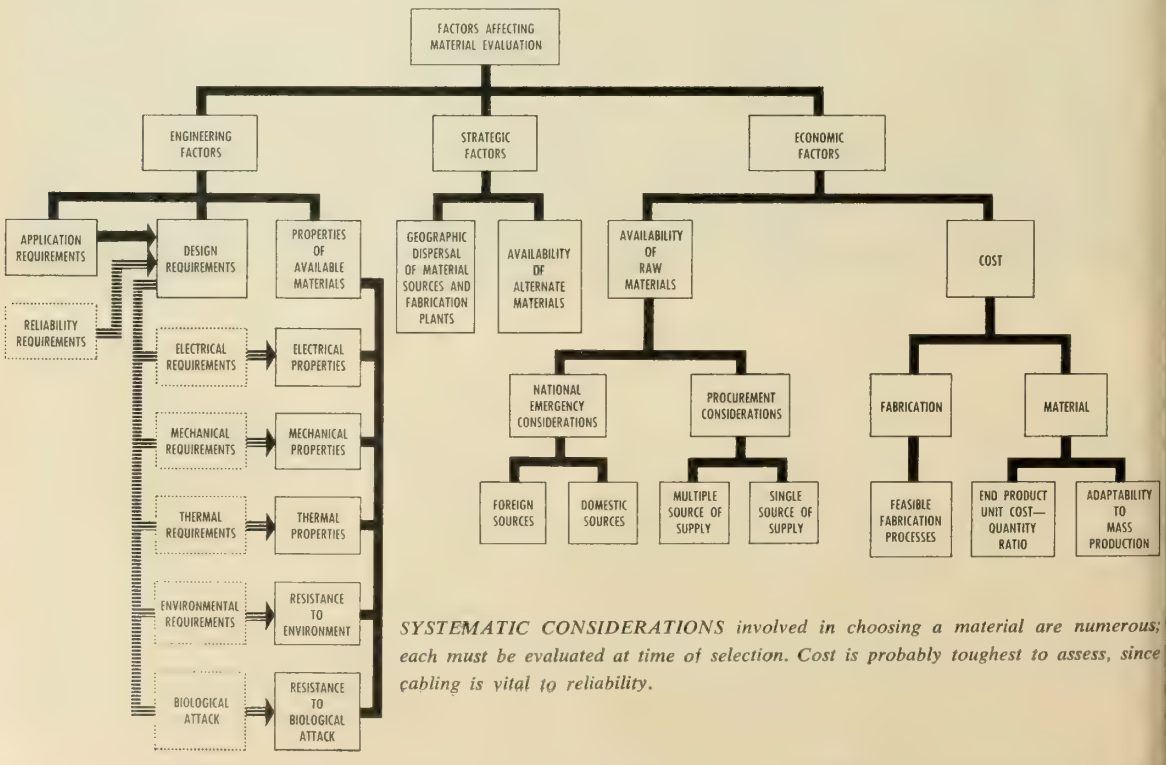
The application of such a common sense system runs right into a number of obstacles. Certain qualities that assume importance under extreme environmental conditions are not normally measured. One example is the modulus of elasticity at the lower temperature limit of MIL-C-13777B.

Manufacturers do not have authoritative standards available for the compounding and fabrication of materials when their performance must exceed present military standards.

Another difficulty is that complete data is not available on a number of compounded insulation materials. Part of this may be due to proprietary considerations and part could be due to such a variability of properties in complex compounds. that the manufacturer himself may not know all of the data.

The Engineering Group did find an existing need for improved materials for use as sheath and primary insulations in the construction of umbilical cables. This application would require brief subjection to temperatures in the order of 1800°F.

The RCA effort has made possible the direct relating of cable system application requirements to measurable material properties over a much broader range than before. But it could be extended to exploit miniaturization, reduced weight, maximum flexibility, stability at high ambient temperatures, increased cable life expectancy and, the old favorite, cost reduction. ⁂




*SYSTEMATIC CONSIDERATIONS involved in choosing a material are numerous; each must be evaluated at time of selection. Cost is probably toughest to assess, since cabling is vital to reliability.*

(Continued from page 23)

## Operational Parameters of Functionailzed Cable Groups Recommended for Standardization

| FUNCTIONALIZED CABLE GROUP | TYPICAL APPLICATION | CURRENT RANGE | VOLTAGE RANGE | FREQUENCY RANGE | COMMENTS |
|---|---|---|---|---|---|
| PRIMARY POWER CABLES | DC power<br>3$\phi$ 3-wire AC power<br>3$\phi$ 4-wire AC power | 0-200 amps/$\phi$ AC<br>0-450 amps DC | 0-440 vrms | 0-400 cps | Additional conductors are provided in this design to meet existing requirement for auxiliary DC pwr, separate grounding, voltage control, and phone loops. |
| POWER DIST./ CONTROL CABLES | Distributed AC/DC power<br>Relay control and indicator lamp voltages | 0-20 amps distributed power<br>0-200 milliamps control | 0-440 vrms distributed power<br>0-28 vdc control | 0-400 cps | Distributed power and control signals do not adversely interact. |
| SYNCHRO-SERVO RESOLVER CABLES | Ind. & pos. data from synchros, resolvers and servos.<br>Computer info | 0-3 amps | 0-120 vrms | 0-400 cps | This cable design can also meet requirement for phone loops when needed. |
| RF AND PULSE CABLES | Hi-voltage pulse<br>Hi-pwr RF pulse<br>RF transmission | —— | 0-10 kvrms for hi-voltage and hi-power cables<br>0-5 kvrms for RF cables | Up to 100 mc for HV cables<br>Up to 3000 mc for HP and RF cables | Miniature and standard size cables are included in this group. Characteristic impedance of cables are in accordance with accepted standards. |
| GEN. PURPOSE CABLES | Limited numbers of following signal types in combination or singularly:<br>DC power Computer info<br>AC power Telephone<br>Control Indicator<br>B-supply | 0-5 amps AC/DC | 0-120 vrms<br>0-28 vdc | 0-400 cps | Requirement for general purpose cables of more than 40 conductors cannot be foreseen. |

*SYSTEMATIC CONSIDERATIONS involved in choosing a material are numerous but each has to be evaluated in the light of its significance at the time of selection. Cost is probably the most difficult to assess because missile system reliability is intimately related to the cabling system. Thus the most uneconomical material may be a cost-cutter.*

information on properties of materials.

–Absence of a technically adequate, maintainable, and non-proprietary line of electrical connectors suitable for portable heavy-duty field service.

–Lack of analytical means of accurately relating cable system application requirements to design requirements without incurring considerable prototyping costs.

• **Five volumes**—The final results of the study were presented to ARGMA in a five-volume final report.

The first (vol. I.1) contains the technical summary and recommendations.

Vol. I.2 is a survey of ground cable system requirements of Ordnance guided missile systems. Requirements investigated in the survey include logistics, human engineering, and environmental, mechanical, and electrical requirements.

The comprehensive vol. II presents the results of engineering research studies into the electrical, thermal, mechanical, and materials characteristics of ground cable systems.

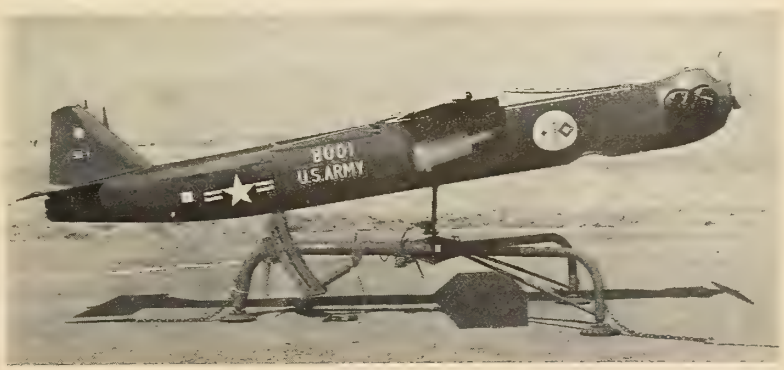
Vol. III is a catalog of Ordnance guided-missile ground-cable system components compiled in the course of the study.

Vol. IV covers the selection, specification and evaluation of cable system components. ⁂

## British to Receive Fleet of SD-1 Drones

THIRTY-TWO SD-1 Combat Surveillance Drones are being turned out at the Radioplane Division of Northrop Corp. for delivery to the United Kingdom expected in May.

The highly mobile SD-1, shown in the accompanying photo in take-off position on a zero-length launcher, is operational with U.S. Army field units in this country and abroad. It can be quickly positioned and zero-length-launched in rough terrain.



# Standardization 'Engineering' Is a

***Advanced military systems suffer badly from lack of standards or use of outmoded criteria; DOD approach marred by awkwardness, dearth of data***

STANDARDIZATION is losing ground in the battle to provide parts and components equal to the requirements imposed by high-performance military electronic equipment.

Policy statements by the Department of Defense seem to encourage standardization, but the number of "special items" finding their way into missile and other complex military electromechanical systems continues to grow.

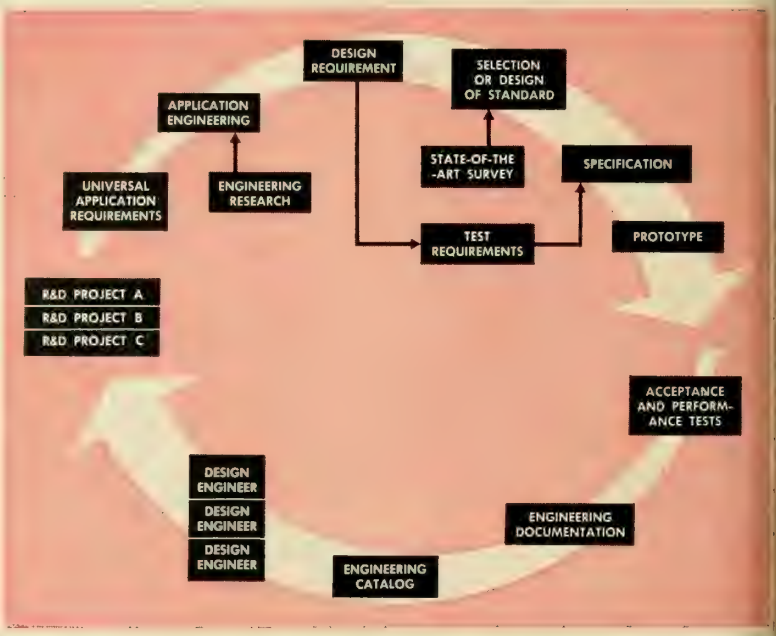
The near-chaos existing in the wire, cable, and connector components classes—discussed in other sections of this special report—is evidence of this overall problem.

DOD's standardization effort has been successful to a considerable extent —in component areas that historically have been standardized. But the effort in component areas peculiar to advanced military systems, or where there is no prior experience with inter- as well as intra-system standardization, has been less successful, frustratingly so.

It is a well-known and much-discussed fact that the lack of standardization, or the adoption of obsolescent items as standards, has created problems in system design and in providing logistic support for operational first- and second-generation missile systems.

An indication of the state of affairs, in just one component area, is the recent estimate that line-item requirements for ground-cable system components can be reduced to less than 50% of the current number through controlled development and implementation of standard items.

Because specific data is not available, the problem cannot be measured in dollars. But it is no longer uncommon for a guided missile ground cable system to cost more than $3 million per site—in some instances as much as $10 million. Add to these direct costs the burden of duplicative component research, documentation, and inventory, and the dollar loss from non-standardization or ineffective standardization in this single area begins to assume significant proportions.




*STANDARDIZATION is a closed loop. Process begins with requirements and delivers components of proper technical quality to the designer engineer for implementation.*

The scope and complexity of the overall DOD standardization program is truly awesome. At last count, just under four million separate items, divided for administrative and cataloging purposes into 547 Federal Stock Classes, are being maintained in the Federal supply system. It has been reliably estimated that more than 200,000 separate items are being added to the system each year—a considerable portion of these resulting from missile system R&D or R&D related to the missile area.

The theory and practice of system engineering was developed to cope with the problems of complex system R&D. It is becoming evident that an equivalent and complementary theory of standards engineering must be developed, to economically provide the system designer with technically adequate and standardized components. Component development and standardization is falling behind the quickening pace of system development; the rate at which it is being left behind will increase as the full effect of systems management techniques, such as PERT on the Navy *Polaris* program and PEP on Air Force programs, is felt.

Willard R. Fazar, member of the *Polaris* management team, says: "Modern system management techniques have enabled us to reduce the R&D cycle, for major weapon systems, from 7-10 years to 3 years; we are confident that the cycle duration will be reduced even further as the full potential of the PERT approach is realized."

# rgently Needed Development

by Edward W. MacLaren, Jr.
*Government Service Dept.*
*RCA Service Company*

Selection or development of a component for across-the-board standardized use, on the other hand, may take as long as 5 to 10 years to pass from recognition of need through definition of requirement and R&D to final issuance of a military standard. This is admittedly an estimate, but it is representative and indicative of the increasing rate at which systems design is outpacing component standardization.

The purpose of this article is to discuss a few of the many aspects of the DOD standardization program that require attention if it is to meet the challenge with which it is being faced —and to suggest an approach to meeting the challenge.

The major requirement is that the program, as it applies to providing military standards for use in major weapon systems, must be re-oriented to better meet the needs of its principle customer"—the system designer. To satisfy these needs, and to provide some hope of stemming the rising volume of special items going into the military supply system, a capability for timely decisions must be built into the process, and much more emphasis must be placed upon the engineering aspects of standardization.

• **Cumbersome process**—As currently practiced, determination of military standards is a cumbersome process. Too often, agreement upon a standard of several years in the making and, once reached, is based upon insufficient objective data and knowledge, thanks to lack of funding for supportive engineering. As a result, adopted standards too frequently trail the component state of the art and never find their way into actual system usage.

A second pitfall is the implementation of obsolescent standards to detriment of system performance. In one actual case, AN connectors, fitted with "C" cable clamps, were used throughout a major ground-cable system installation. The AN connector was selected in this case because "the AN is the connector standard." The installation has suffered continuously because the AN cannot prevent "breathing" around the cable clamp seal. The recurrent trouble appears as "excessive crosstalk during the early morning hours."

The trouble is that moist night air has been drawn into the cable assembly through the deficient connector seal during the cool, early morning hours—hence the "excessive crosstalk." Once the sun comes up, the moisture-laden air inhaled by the cable assembly during the night is exhaled, and the trouble cures itself. It is reported that a maintenance solution other than a costly complete retro-fit with an adequate replacement is still being sought

Connectors which can provide an adequate seal, and which have other desirable design features, were available at the time the installation was made; none of these were standard, however, and no one of the several commercially available lines is interchangeable with the others. Furthermore, there is little hope that a standard providing interchangeability between functionally identical connectors of different commercial lines is forthcoming within the near future. The groundwork has been laid for formulation of a standard for this component area, but the standardization process discourages effective follow-up.

The cumbersomeness of the DOD standardization process lies in its lengthy and complex approval and concurrence procedure. Contributing to the problem is the fact that many such concurrences and approvals must come from agencies having no direct knowledge of existing application requirements, or from agencies whose concern is with minor systems. As a result, it is increasingly believed, system designers often select a special item for which some, not always reliable, performance data are available, rather than a standard item for which they have little data.

• **Inaccessibility of data**—Current methods of cataloging and documenting engineering information on standards present an additional problem. This is probably best described as access difficulty. To be used, a standard must be "advertised"—its existence must be brought to the attention of its potential user. Additionally, the potential user must be drawn, by its cogency and usefulness, to seek out the standard. And, of greatest importance, access to the standard must be made an easy and routine matter by proper choice of effective format.

In seeking a workable solution to this problem, we should again consider the needs and habits of the principal customer for the product of the standardization program. Design engineers are accustomed to using commercially provided parts catalogs, in which parts are graphically presented and considerable engineering data is provided. The Federal catalog system does not provide an equivalent parts catalog.

The AF Technical Information File (M/R, June 15, 1959) is a step in the right direction, but technical data required by the designer is lacking. Also, the TIF is limited to equipment costing more than $2000.

Problems of this kind must be solved if the standardization effort is to achieve its full potential as an important aid in systems design and an instrument for long-term logistic simplification. Incompleteness of data and difficulty in gaining access to data are two major reasons why design engineers look upon standardization as a hindrance rather than an aid.

• **Engineering needed**—To provide state-of-the-art standards, a well-planned standardization project must proceed on the assumption that an adequate engineering staff will be provided. Outward indications are that current DOD funding for standardiza-

# AiResearch pressure suit cooling unit

*provides maximum pilot comfort on the ground*



*This portable, lightweight package* keeps the pilot cool and comfortable on the ground in his flight pressure suit from one to two hours. Utilizing cryogenic liquid oxygen as the coolant, it requires no electric power or other connecting supplies which might hinder the pilot's mobility.

Easily carried by hand or slung from the shoulder, the AiResearch unit can cool a pilot wearing either full or partial pressure suit during travel to and from his aircraft, preflight checkout and while seated in the cockpit. Pure oxygen for prebreathing can also be provided as a simultaneous function.

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• *Please direct inquiries to Los Angeles Division*

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ion does not provide for adequate ngineering effort. A form of psuedo-tandardization can be accomplished hrough a cursory search of technical terature on the component area nder study, but this seldom produces ecommendations reflecting current tate-of-the-art technology.

Also, a careful study of the results f representative standardization udies will reveal that most, technic-lly speaking, are simplification studies. hat is, their end result is elimination f duplication within the component r specification area under considera-on. They do not as a rule provide sound basis for up-dating of the omponent state of the art and agree-ient upon common specification of form, fit, and function"—the true oal of standardization. Simplification often beneficial—in many cases xtremely so—and can be performed reliminary to, or concurrent with andardization. But it is not engineer-ig standardization of the degree re-uired to provide system designers ith a useful design tool.

The engineering judgments re-uired to select or design a procur-ble standard of proper technical uality can be extremely complex.

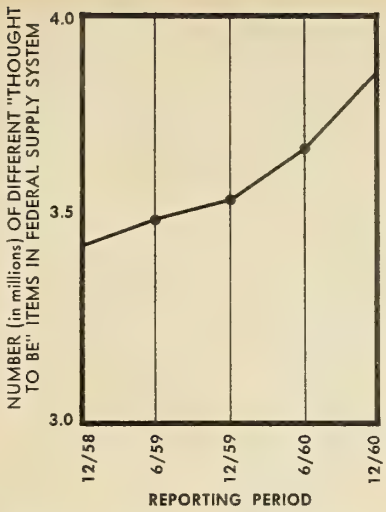
It is widely believed by those not cquainted with requirements of the eapon system designer that com-onent standardization and specifica-on consists of "counting nuts and olts," writing a specification, and reparing catalogs.

This is not the case. The degree f proficiency, in materials engineer-g alone, required to prepare a suit-ble standard is usually more than one an can handle.

The more important topical areas at must be investigated to equip a andards engineering group with suf-cient background to arrive at satis-ctory standardization judgments are:

–Systems Studies
–Electrical Studies
–Mechanical Studies
–Heat Transfer Studies
–Materials of Construction Studies
–Design Techniques
–Industrial Survey Studies
–Testing Techniques
–Reliability Factors
–Human Factors

• **Approach**—The RCA Systems ngineering Facility (Alexandria, Va.), its final report prepared for an RGMA cable and connector stand-dization and improvement contract, tlines a planned project approach to andards Engineering (see story page ). The five-volume report presents andards Engineering as a four-step ocess consisting of systems engin-




*FEDERAL SUPPLY list adds over 200,-000 items annually, much of it from mis-sile R&D.*

eering, design engineering, engineering documentation and cataloging, and standards administration.

The staffing and planned engineering approach outlined in the report and summarized above provides capabilities for:

–Precise definition of system requirements.

–Knowledgeable relating of systems requirements to design requirements.

–Competency to seek and implement optimum solutions to engineering problems posed by application requirements.

–Translation of engineering design requirements into technically complete specifications.

–Close coordination with prime system managers.

–Close coordination with industrial groups.

–Adequate documentation of quality assurance, performance, and catalog data.

Study results such as these, prepared by an engineering team well versed in the philosophy of standards engineering, provide the basis of objective data and substantiated engineering judgment. Of perhaps greater importance, a firm engineering background has been established preparatory to presenting the resultant standard for implementation.

• **Marriage of System R&D and Component Standarization**—The consensus among those familiar with DOD standardization is that component standardization, to be effective, must be accomplished concurrent with, and in direct support of, system R&D. Current practice, forced into being over the years by the realities of meeting ever-shortening R&D deadlines, is that a concerted effort toward component standarization comes into the picture only after a missile system has been released by R&D. Even at that stage, the standardization mission is seldom well-defined.

The post-R&D approach is based upon the premises that (1) standardization falls within the realm of product improvement and industrial engineering, and (2) that the cost of retro-fitting with standard components will not be prohibitive. With the advent of systems more complex by several orders of magnitude than any previously known, these premises lost their validity. The cost of drafting and publication changes alone, that would be required to accommodate post-R&D back-fitting with standards, is sufficient to prompt decisions against it.

O. D. Lambert, Assistant to the Chief of the ARGMA Standardization Branch, who has day-to-day familiarity with the problems of standardizing components for complex systems, states: "The ultimate benefit of standardization within complex electro-mechanical systems will never be realized until full consideration is given to component standardization at the R&D phase as well as during the normal product improvement and industrial engineering phases of systems development. Once a complex system has passed beyond the R&D phase, the cost of retro-fitting the system with standard components is, with few exceptions, prohibitive unless such consideration has been a part of the R&D approach."

• **Conclusions**—DOD Standardization Manual M201 sets "maximum incorporation of standard items in new design," without retarding engineering progress, as the objective of the DOD standardization program. The quickening pace of advanced systems R&D and increasing demands for higher component reliability is presenting the program with new challenges. Accomplishment of the stated program objective in the face of these new challenges will require:

–Streamlined standardization decision making.

–Increased engineering activity within the program.

–Reorientation of the program to place much needed additional emphasis upon an engineering approach.

–Provision for long-range continuous program planning.

–Provision for assembly and documentation of engineering data that is useful, readily accessible, and rapidly disseminated to design engineers.

–Provision, on an across-the-board basis, for closer coordination of the system R&D and component standardization functions. ⌗

## Wire & Cable Crisis

*(Continued from page 21)*

with the bird. When it came time to install, however, it was found that the cable terminations required too much space to allow mating with the receptacles. The expensive molded cable then had to be split and the receptacles relocated to make the connectors fit.

Another problem exists in the chemistry of the different materials that make up complex cables. Incompatible materials have resulted in insulation breakdown in numerous instances. Systems that work well for a period of time suddenly are inoperative. Many agree that chemistry is perhaps the biggest problem in the industry (see p. 22).

• **What's been done**—No doubt the best answer to the wire and cable situation so far is the implementation of MIL-C-13777—a general specification for GSE and umbilical cabling. This has recently been classified a "coordinated document"—which means that all military services concur on its contents and agree to use it. At present, 11 suppliers have qualified their products to this spec. When the military procures wire and cable, it must accept bids from any or all of these qualified suppliers.

Most missile prime contractors accept and use "Triple-7"—as it's known in the trade—but are under no requirement to do so. Some have used it as a basis for their own specs. Some include a few arbitrary modifications to limit the number of qualified bidders.

Most agree that Triple-7 is a "good" spec but that it, too, has its limitations. For one thing, it's hard to keep it abreast of developments. This spec originally covered only latex rubber insulation; a major hassle evolved when efforts were made to change it to admit plastic coverings. (One manufacturer claims that after plastics were qualified, cable costs came down approximately 40%.)

Work is in process to qualify Teflon under Triple-7. Other materials will be added as they are developed and proved out—and after a certain time interval. Reduction in cable sizes, new connectors, and other improvements—such a fungus resistance standards—will b added in the course of time.

There have been complaints tha Triple-7 was really written by cabl manufacturers around the particula type of construction best suited to thei own facilities—and aimed at excludin competitors. Also, there's some criti cism that tests specified by Triple- should be better correlated to actua field usage.

Connector manufacturers say tha Triple-7 poses some problems for them too. Principal complaint has to do wit steel reinforcing strands on small wir (AWG No. 15 down). This increase the overall size of the wire to a poin at which it won't fit in many existin connectors. This is circumvented b clipping the strands short of the con nector solder (or crimp) connectior

Problems have also arisen from th steel cutting the copper conductor i cables subject to heavy flexing condi tions. Some feel that the steel rein forcing is not necessary.

The wire and cable business is nov much more competitive than it was short time ago—and the consensus i that this is to the good. Manufacturer say that their facilities are now mor than adequate and heavier competitio makes mandatory a continuous searc for better processes and lower costs.

• **What needs to be done**—High o the list of things to be done is standard ization (see p. 28). With more standar configurations, cable manufacturer could stock quantities of cable and fi orders in a few days.

Whatever its merits, Triple-7 can not be effective unless it is enforced b the military. So long as missile prime are free to deviate from the spec, de sired ends cannot be accomplished.

All involved in the missile wir and cable business are agreed that mor lead time and design concurrence ar essential. So long as the cabling is le until last, poor design and problem will naturally result.

A single group set up by DOD ha been recommended as one possible so lution to the problem. Such a grou adequately funded, would develop ba sic data engineering principles, appl cable to wire and cable, collect catalo information on existing component and, in general, serve as a consultan to prime contractors and as advisor t the military. The group would keep u with the state of the art and develo standards and guidelines.

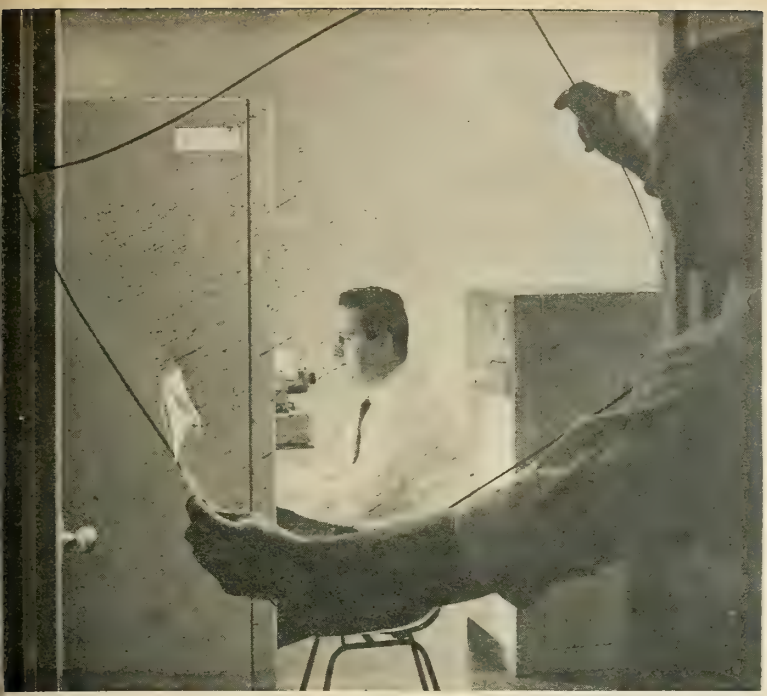
Another proposal would hav Army's Frankford Arsenal, as co ordinating body, regularly call to gether representatives of the militar missile primes, and cable and connecto manufacturers to work out their prob lems on a continuing basis.

### Cable Manufacturers qualified under MIL-C-13777

**Anaconda Cable Co., Crescent Eng. & Research Co., General Cable Corp., General Electric Co., Kaiser Corp., Pacific Automation Products, Phelps Dodge Copper Products Corp., Rome Cable Corp., Surprenant Mfg. Co., Okonite Co., Wm. Brand-Rex Div.**




**STRATEGIC AEROSPACE CENTER** • Lockheed/Georgia is next door to Huntsville and Cape Canaveral. This strategic geographic location eliminates excessive transportation costs, makes technical liaison more efficient, and reduces the overall time span of aerospace programs. And the Georgia Division is big enough physically to handle any program yet conceived—big enough in capability to take on the full gamut of advanced research and manufacturing jobs. **LOCKHEED/GEORGIA**
MARIETTA, GEORGIA



*END RESULT of system is positive film overlay with names, symbols and numbers.*

# Army Will Speed Mapping

THE U.S. ARMY Map Service is speeding up its map-making process with a new electro-optical system.

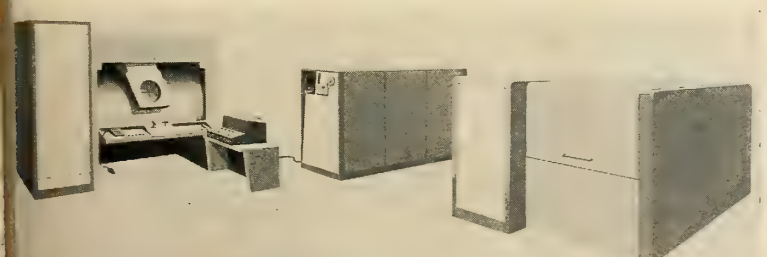
Developed by Concord Controls, Inc., of Boston, the device is an automatic type-placement system which cuts down the process of applying place names to one-half the time. The operation previously required many tedious manual operations and involved duplication of steps.

The system combines features of a pair of precise coordinatographs with an electronic digital recording and positioning system and a precise stroboscopic projector. The operator locates every name on the map precisely where required, and at the same time selects the type size and style.

The type order consists of a typescript and a punched paper tape. A second punched tape contains precise digital data describing the exact location and orientation of each of the map names. The position tape and a 70 mm film strip of the names from a phototypesetter, are coordinated to expose the final names photopositive directly and automatically.

The programer allows an operator to process approximately 100 names per hour with an accuracy of ±0.0025 inch. The photocoordinatograph positions and exposes names on the photopositive at approximately 1000 an hour.

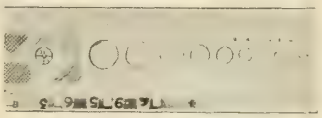
Army Map Service has launched a number of new systems designed to speed up mapmaking in anticipation of the large number of photographs from the *Samos* satellite and other reconnaissance programs. The Concord equipment will be installed in the next two months.



*STEM INCLUDES programer (left), control console (center), photocoordinatograph.*


# NARROW-CHANNEL PHOTOGRAPHY

For people with the problem of photographing the interior of long, narrow channels, Kollmorgen has developed unusual devices capable of recording on film channels as narrow as 1/32 of an inch.



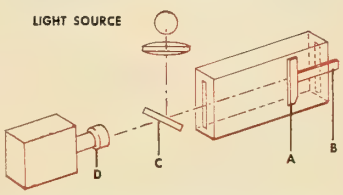
Above, actual size, is a test film of circles and numerals placed within a 1/32"-wide channel.



Above is a *panoramic* view of a continuous section of the same film . . . with marks enlarged 8x.



Pitting, corrosion, fracture and other defects of interior walls can be continuously recorded with full-dimensional accuracy . . . of exceptional value in quality control operations.




The secret of our insight: A highly precise 45° mirror (A), mounted on a reed (B), is inserted in one end of the channel. A beam splitter (C) directs a powerful light into the channel from the opposite end which is reflected by the mirror onto the sidewall. The photographic leg of the system receives the image from the channel mirror and through the beam splitter. A camera objective (D) focuses the image on the film. The channel is advanced by a carriage in precise synchronization with the advance of film. Result: a continuous, clear photographic record of the entire channel.

Various modifications of this device have been applied to channels up to six feet long. For longer and wider channels we have designed a miniature self-propelled camera, mirror and light source capable of presenting a continuous image on film with resolution sufficient to reveal scratches and hair-line cracks smaller than .010 inch.

*If you need special insight on "inaccessible" interiors, or information on other unusual applications of optics/electronics/mechanics—let's talk it over.*

Write Dept. 6-3

KOLLMORGEN CORPORATION
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# First 'Streetcar' Due to Go Soon

THE FIRST of the "streetcar" satellites—to be launched on a periodic schedule with whatever experiments are going its way—is due for flight this summer.

The *Orbiting Solar Observatory*, a sophisticated axle-spinning spacecraft weighing upwards of 350 lbs., is making the first of three annual launches aimed at a circular orbit of about 350 miles—below the Van Allen belts.

The *OSO*, designated *S-16* by the National Aeronautics and Space Administration, will be lifted by a *Delta* launch vehicle from Cape Canaveral. A backup booster and spacecraft will be available in the event of failure. The 1962 *OSO* will also be boosted by a *Delta*. Booster for the 1963 flight is not decided because there are no present plans to procure *Delta* vehicles beyond 1962. The booster will be whatever is available in its power class at that time.

*S-16* is designed to study a series of earth-sun relationships for a minimum of six months. With luck, says Dr. Nancy G. Roman, NASA chief of astronomy and astrophysics, it may remain in operation for a whole year. Operation longer than a year is doubtful because nitrogen used for attitude control jets will probably run out.

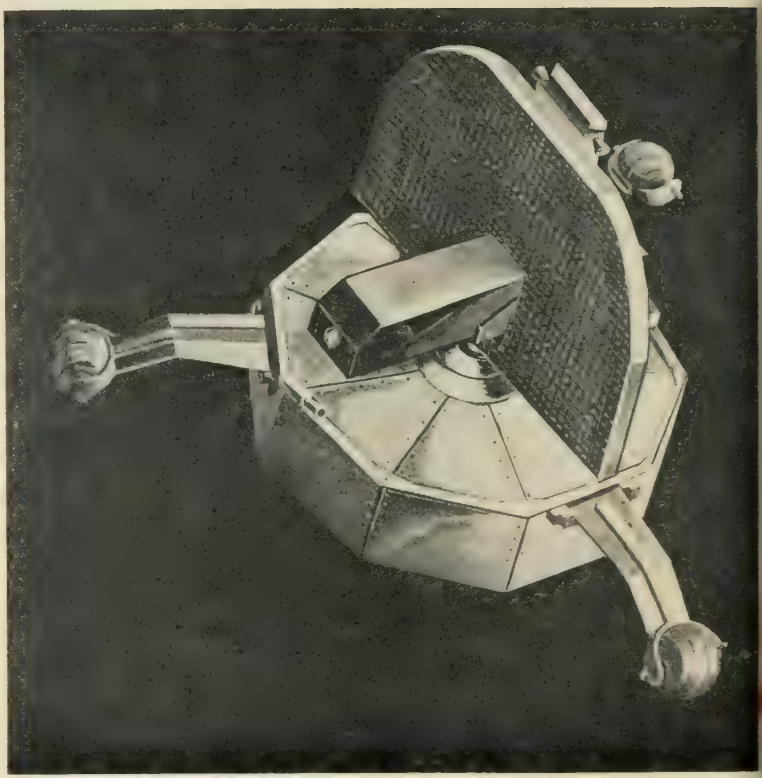
The spacecraft consists of two major segments—a 40-in.-diameter spinning wheel with three arms extending out to 92-in.-diameter, and a vertical "sail" stabilized so that it permanently faces the sun to gather maximum energy with its solar cells. The wheel spins at 30 rpm.

Nickel-cadmium batteries continually charged by the solar cells supply 28 watts of power for the experiments, two data transmitters and a beacon.

The nitrogen system provides attitude control on two axes. The plane of the spinning wheel is held by precession within 5° of a line joining the satellite and the sun. The non-spinning portion is designed to hold the solar cells pointing at the sun within a tolerance of 2′ or possibly 1′.

The three fiber glass-plastic nitrogen bottles are set on the extended members (see illustration) to increase the wheel's moment of inertia for gyroscopic stability. The gas is fed back and fired from jets on the main body.

Similar nitrogen jet controls have operated successfully on several sounding rocket flights. But their use on *S-16* will be the first time on a satellite.



*NASA ARTIST'S CONCEPTION of OSO shows how three fiber glass-plastic nitrogen bottles on extended members—first use of technique on a satellite.*

Aluminum construction is used on the 2-ft.-thick spinning portion and the solar "sail." Two experiments will be carried on the "sail" because of the necessity for pointing at the sun.

Pointed experiments are an X-ray spectrometer in the 10-400 Angstrom range, with 1 Angstrom resolution, prepared by the Goddard Space Flight Center, and a high-dispersion shell grating, prepared by the University of Colorado, to monitor the solar Lyman alpha radiation.

These experiments will be on the spinning wheel:

–Hard gamma ray counter—in the range of 100-500 million electron volts —by the University of Rochester.

–Soft gamma ray monitor—in the range of 0.1-5 mev—by the University of Minnesota.

–Low-energy gamma ray monitor, by Goddard SFC.

–Materials behavior in space, a measurement of the temperature of seven different coatings painted on control surface, indicating the albed and thus the degree of sublimation o the material, by Ames Research Cente

–Barium fluoride counters to mon tor neutron albedo, by the Universit of California.

–Electron-proton discriminator, t learn how far down the Van Allen be extends, by the University of Californi

–X-ray ion chambers in the 1-1 Angstrom range, to calibrate the lo end of the spectrum, by Goddard SF

–Photo cells and ionization chan bers for general monitoring of the sun behavior, by Goddard SFC.

Ball Brothers, Boulder, Colo., prime contractor on the spacecraft. D Roman said NASA hopes to continu the *OSO* spacecraft even after the al purpose *Orbiting Geophysical Observa tory* satellites come into use in 196 She said *OSO* requirements of pointin control and orbits are different fro those of *OGO*.

# BIG BOOSTER

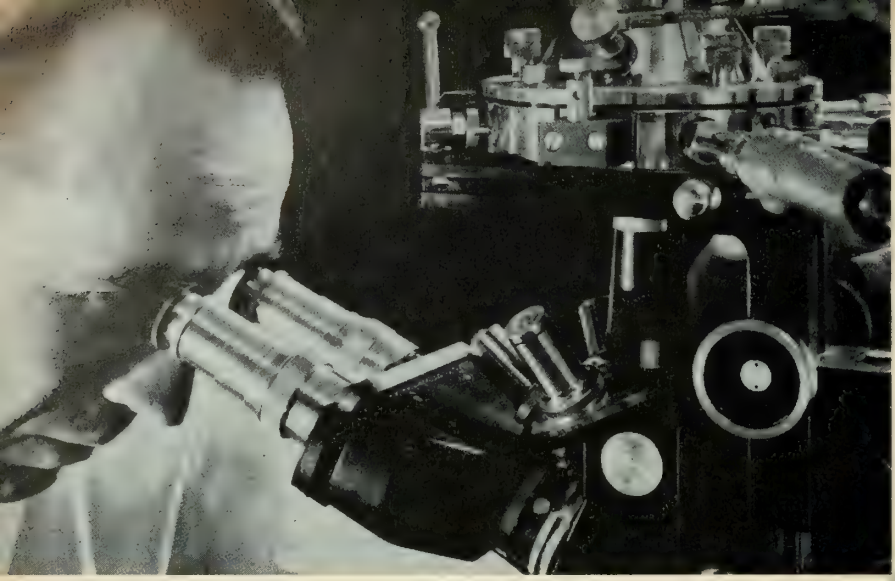
Thiokol is producing the largest single solid rocket motor to be flight tested, first stage of the Minuteman. Reliability has been demonstrated by a successful flight test and an 8-shot launch capability program. The same facilities, scientific and technical talents, and skilled management team responsible for developing this powerplant in record time are capable of delivering space-age size boosters for earth satellites and solar system exploration.

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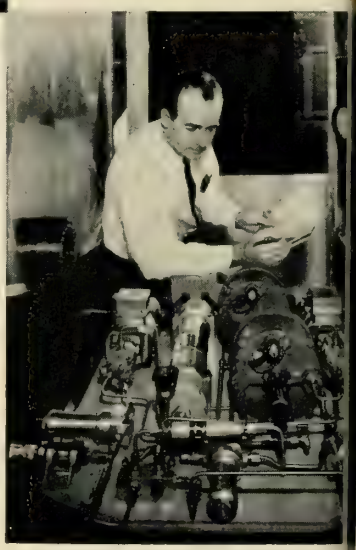
### In technology and facility, Vickers continually matches your needs

New fluid power and hot gas systems for aerospace vehicles still in the idea stages are being developed at Vickers. Techniques for converting basic energy into precisely controlled power are continuously being sought by experienced teams of research specialists utilizing the finest scientific equipment.

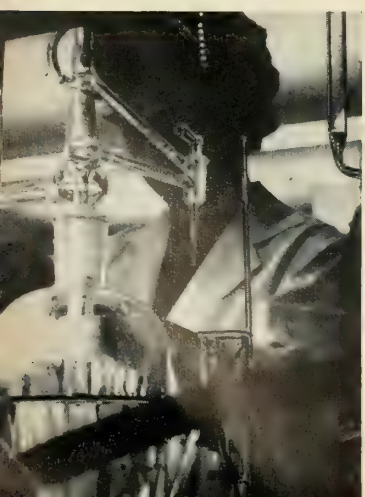
Creative application of the sciences of hydrodynamics, aerothermodynamics, heat transfer, metallurgy and chemistry have been productively blended with Vickers vast experience in the instrumentation and control fields.

The principal effort of Vickers applied research is now concentrated in three areas: 1. advanced systems and components for attitude controls, 2. secondary rocket nozzle injection and 3. hot gas servo actuation. In addition, continuous refinements are being made to the high performance Vickers hydraulic pumps and motors.

The experienced Vickers Application Engineer in your area will welcome the opportunity to fill you in on additional details. In the meantime, write or call for Bulletin A-6002.



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Analog computer (shown) and solid state Univac digital computer give Vickers the important edge in solving complex engineering problems.

# Seventh Little Joe Shot Seen

## *Key to man-in-space launch timing is test at Cape of improved Mercury Redstone*

**by Jay Holmes**

A SEVENTH *Little Joe* flight will be held in the Project *Mercury* test program, but the flight need not necessarily delay further the first manned suborbital flight.

The timing of *Mercury Redstone* 3, the first manned flight, depends largely on the result of an imminent *Mercury Redstone* ballistic development test *(MR-BD)*, carrying a dummy capsule. It would take up to three weeks or more to put together another *Little Joe*.

*Little Joe 6*, launched from Wallops Island, Va., March 18, failed to test the *Mercury* capsule enough to qualify it for manned orbital flight. But the conditions developed in the test were much more severe than could be imposed on a suborbital *Redstone* mission, officials of the National Aeronautics and Space Administration said. The escape system operated and William Bland, capsule project officer, said he saw no reason why an astronaut could not have survived.

The *Little Joe* was designed to set off the capsule escape system at a time during powered upward flight when maximum compressive air loading (max Q) would have been imposed on the bell-shaped capsule. However, there was a malfunction in the test system. As a result, the escape maneuver took place 27 sec. later and 5000 ft. higher than planned. The Q load was only about 50% of that desired.

Although officials of NASA's Space Task Group would say only that another *Little Joe* shot may be held, it appears an obvious decision, since *Little Joe* flights are much cheaper than *Redstone* or *Atlas* flights as a means of obtaining test information.

• **Triple trouble**—Three other malfunctions took place on the *Little Joe* flight:

—A collision in flight—with either the escape tower or the retro package—caused slight damage to the capsule exterior.

—Both the drogue parachute and the main chute were deployed at altitude, lengthening the flight from a planned 8½ min. to 23 min. and allowing winds aloft to carry the capsule to landing 18 miles offshore—about 12 miles farther than planned.

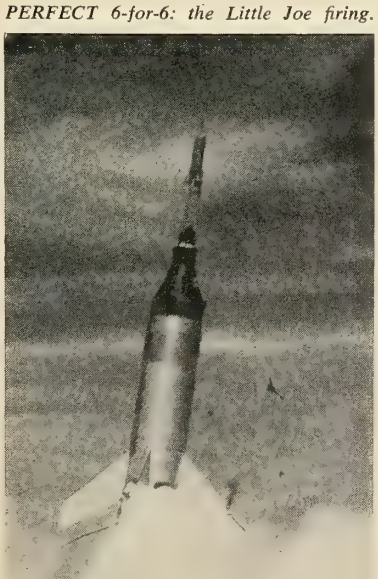
—The parachutes failed to separate from the capsule on impact with the sea. As a result, the capsule could not be picked up by helicopter until a ship steamed alongside and men from the ship could disengage the chutes.

NASA officials doubted that any of the malfunctions was serious enough to interfere with the schedule of the planned *Redstone* flight. Nevertheless, they began a thorough study of the telemetry prior to making any decision.



*LITTLE JOE 6 capsule is carried by Marine helicopter after March 18 recovery.*

*PERFECT 6-for-6: the Little Joe firing.*



• **Proving improvements**—At Cape Canaveral, meanwhile, NASA's Marshall Space Flight Center made final preparations for the *MR-BD* flight, scheduled for last weekend or early this week. The *Redstone* booster was to carry a boilerplate capsule built in the early days of the program by STG. No separation or recovery was planned.

NASA said the *Redstone* flight was designed to test corrections in the booster uncovered on the chimpanzee-carrying *MR-2* flight Jan. 31. The difficulties would not endanger a human's survival, NASA said, but the improvements had to be proven in flight.

A NASA statement pointed out that the *Redstone* used for *Mercury* flights is a second-generation booster different in many respects from the *Redstone* fired extensively by the Army.

The two major problems that developed on *MR-2* were failure of the thrust regulator and a low-frequency vibration of the entire booster-capsule assembly. The vibration caused a snake-like motion through the atmosphere that, in itself, was not a serious threat to flight stability. However, the booster's attitude control system sensed the motions and was taxed to the utmost trying to overcome the vibration.

The thrust regulator was corrected with a relatively minor adjustment. Two steps were taken to solve the vibration problem. First, an electrical filter was wired into the attitude control system to cut out signals from the low-energy, long-wave vibration. Second, a thick coating, similar to an automobile undercoating, was applied to the inner skin of the instrument compartment to reduce the amplitude.

The booster will be the first fabricated for Project *Mercury* by the Chrysler Corp. The first two were manufactured by NASA at Huntsville.

On *Little Joe 6*, the escape rockets were to have been set off at 35,000 ft. altitude, about 35 sec. after takeoff, so as to encounter max Q. But the actual firing took place 62 sec. after takeoff, at 40,000 ft.

• **Record intact**—Liftoff at 11:48 a.m. was followed by landing at 12:11 p.m., with a Marine helicopter following it down. The USS Recoverer, a small salvage vessel, pulled alongside at 12:53. Men from the Recoverer disengaged the chutes and the helicopter put it aboard ship at 12:59.

The new landing bag worked well, keeping the capsule upright all the time it was in the water.

North American Aviation, which developed the *Little Joe* booster for Project *Mercury*, reported that cost of the six booster airframes, a launcher and all checkout equipment was about $1 million. N.A. noted that *Little Joe* has a perfect record in six firings. ⌗

# IRE Hears $30-Billion Market May Come by '70

***Convention is largest technical gathering ever held; missile/space interest dominates exhibits, sessions; recruiting at fever pitch***

NEW YORK—Predictions of a $30-billion Electronics Market by 1970 sparked the opening of the giant 1961 Institute of Radio Engineers International Convention here last week. And the bulk of this market, said IRE top management, will be found in the missile/space and related industries.

Space communications, already being explored commercially by a number of companies, is expected to be one of the leaders in this expansion. Progress in solid-state physics, along with advances in computing equipment and automation, will contribute heavily.

Playing to some 70,000-plus engineers and scientists from all over the U.S. and 40 foreign countries, the 1961 IRE was the largest technical meeting ever staged. Over three-fourths of the technical sessions were devoted to areas specifically or indirectly connected with missile/space applications. The bulk of the 850 exhibits of components, equipment, and systems were also aimed at missiles and space.

• **Recruiting accelerated**—Proselyting of engineering talent was at an even higher pitch than usual this year. The New York Times carried 16 full pages of display ads of engineers and scientists in the Sunday issue preceding the opening of the show. Other papers carried proportional amounts of "Engineers-Wanted" ads.

Forty-three companies banded together in a "Career Center" to handle job applicants in a mass-production operation. Others maintained elaborate hospitality and recruiting suites in their efforts to fill openings ranging from junior engineers to vice-presidents. One professional placement service offered registrants a chance to win a $600 color television set, shipped free to the lucky winner's home.

• **Highlights of papers**—During the four-day meeting, 265 papers were presented in 54 technical sessions covering 28 branches of the electronics art—ranging from space electronics to graduate education. A forerunner of the long awaited flat video screen, replacement for the conventional cathode ray tube, has been developed by General Telephone and Electronics Laboratories, Inc.

The inventor of the solid-state screen, Stephen Yando, described his device as a half-inch thick panel of lead zirconate-titanate that uses piezoelectric and electroluminescent properties of the material to produce a moving lighted image.

When acoustic pulses are propagated across such a thin panel, said Yando, localized electric fields are produced on the surface through direct piezoelectric effect. These interact with an electroluminescent phosphor layer to produce light. Size and shape of the lighted area is controlled by the metho and timing of input-voltage pulses ap plied to electrodes along the pane boundary.

So far, screens up to 5x5 inche in area have been built. Much mor work is needed, said Yando, to develo fully the new panels, particularly fo background suppression. First applica tions of the device probably will be i military electronic systems, he said.

Highlights of other technical papers

–A new technique for makin extremely small electronic circuits– called "dot component packaging"– with a density of two million com ponents per cubic foot. Present majo application is in space and satellit vehicles but cost reductions in th future will make the tiny parts avail able for commercial use.



–Use of new materials and pr cesses in orders-of-magnitude improv ments of solid-state devices.

–New techniques for lunar explor tion. These included a moon-orbitin satellite equipped with radar altimet and tv system to survey the lunar su face. Another proposed a measur ment of moon-reflected radar signa from earth to aid in navigating a spa craft to a soft lunar landing.

–A pre-detection recording tel metering system.

–The serious implications of hig energy Van Allen radiation effects space vehicle electronic circuitry.

–ASIS (Alert Sensing and Impl mentation System) used to provi flight safety for project *Mercury*. Ti fully automatic decision-making sy tem will sense sub-system malfunctio and initiate an abort command separate the capsule from the *Atl* booster.

–The techniques for the develo

ment of "adaptive control" systems.

–Test results of the first optical (or laser) radar.

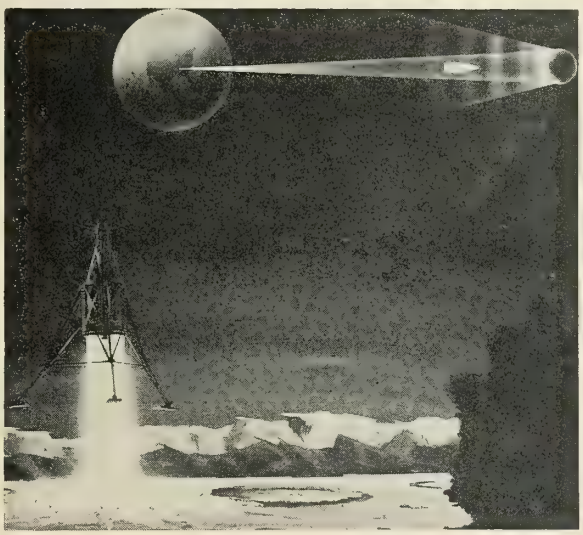
–Space rendezvous system using "logarithmic navigation" for guidance.

–Rocket exhaust trails used as antennas for intra-space radio communications.

–Use of micro-modules for missile/space electronics.

• **Exhibit highlights**—Hardly more than concept two years ago, Tenney Engineering, Inc., featured its space simulators as "shelf items." Employing a model of its 11x12 foot chamber, built for Chance Vought, as typical of its standard systems, Tenney offered environmental test chambers capable of:

–Space altitudes well in excess of 400 miles.



**LEFT:** *On display at IRE Convention is a new "contour cable" developed by Hughes Aircraft Co. to replace bulkeir round wiring in missiles. Flat metal strips are imbedded in plastic ribbon.*

**RIGHT:** *Novel lunar landing proposed by Dr. Frank Dickey, GE radar consultant, uses powerful beam of microwave energy to create "radio-wave atmosphere" for soft-landing of space vehicles.*

–Cryogenic heat sinks using liquid nitrogen for temperatures to 100°K or down to 20°K with liquid helium.

–Simulation of solar energy distribution with a uniformity equal to that experienced on Earth, Venus, Mars, or almost any other known planet.

–One- or two-axis motion simulation with acceleration control of item under test.

American Bosch Arma showed components of its highly advanced 15-lb., 0.3-cu. ft. missile type digital computer (first described in M/R, Feb. 27, 1961). An outgrowth of the *Atlas* CBM all-inertial guidance computer, the new all-solid state system has been in development for the past two years.

ITT Federal Laboratories Division demonstrated a 70-lb. electronic scanning star tracker. Capable of tracking radiant energy from sources in the visible and near-infrared regions (up to 1.2 microns) with a sensitivity to a sixth-magnitude star, the device obviates the conventional need for complex electromechanical scanning and the resulting vibration-caused limitations.

The tracking telescope consists of an optical system, phototube, and electronic circuitry, and it can be gimballed or fixed. The optical lens has a 1-inch aperture, 4-inch focal length, and a 30-minutes-of-arc instantaneous field of view. Although less for smaller fields of view, angular resolution is 9 seconds of arc, according to ITT.

Designed for use in *Nimbus* and *Advent* satellites, the Bendix reaction wheels drew considerable interest. Developed by Eclipse-Pioneer Division, the disc-shaped 5-lb. assembly will be used for orbital-vehicle attitude control by developing and storing momentum. Motor torque, accelerating or decelerating a 3-lb. wheel, is transmitted through the unit monitoring pads to the vehicle structure to maintain constant vehicle attitude or to impart a desired attitude change.

Lockheed's Missile Space Division exhibited its "unfurlable" space inflatable log-periodic antenna. Fabricated of mylar-aluminum foil, 0.0015-inch thick, the antenna is designed for pressure erection from a compact 12-ounce, one-third cubic foot package to a full 8-foot extended unit. Roughly 6 psi will complete inflation, according to Lockheed.

The unit is designed for use in the 70-700 mc range. Two other similar units include an eight-helix element linear array (center frequency of 2300 mc) and a 6-foot multifeed hemispherical antenna for 2400-mc operation. Unfurled, the hemispherical unit is a compact 9-in. dia. x 12-in. long.

One of the many new components shown by ITT Industrial Products Division was its exploding bridgewire firing module. The module operates on 28 volts dc and it is completely solid-state. Weighing less than a pound, the 2x2x5-in. unit can discharge about 2 joules through exploding bridgewire in less than 10 microseconds. The trigger circuit is immune to stray voltages up to 15v ac or dc, either transient or steady state, and also is immune to high-voltage static discharges and high-intensity rf fields, said ITT.

A solid-state static vertical sensor, accurate to one minute of arc was shown by Bendix-Eclipse Pioneer Division. Reliable and inexpensive, according to Bendix, the unit employs electrolytic sensors on two mutually perpendicular axes with its other circuitry to indicate level with respect to these two axes. Unit draws less than 5 watts.

Burroughs Corp. exhibited its now commercially available thinfilm memory planes. First announced last month, the BIP-1000 units are capable of storing 20 eight-bit words.

• **Annual awards**—Some 85 outstanding IRE members were honored at the Annual Awards Dinner. Seventy-six new IRE fellows were recognized and eight received special awards.

The Medal of Honor went to Ernst A. Guillemin, Mass. Institute of Technology, for "Outstanding Scientific and Engineering Achievements."

Ralph Bown, Bell Telephone Laboratories, received the Founders Award for outstanding service to the IRE and outstanding contributions to the radio engineering profession.

Dr. Leo Esaki, Sony Corp. and IBM Research Laboratories, was awarded the Morris N. Liebmann Memorial prize for his work in developing the tunnel diode.

The Browder J. Thompson Memorial prize went to Eiicho Goto, University of Tokyo, for his paper on the parametron.

Harry L. Brueckmann, U.S. Signal Research and Development Laboratories, received the Harry Diamond Memorial prize for contributions to antenna theory and technology.

Manfred Clynes, Rockland State Hospital, Orangeburg, N.Y., received the W. R. G. Baker award for the best paper published in IRE transactions.

The Vladimir K. Zworykin award was presented to Peter C. Goldmark, CBS Laboratories, for his work in the development of television for military reconnaissance and medical education.

Britton Chance, University of Pennsylvania, received the W. J. Marlock Memorial award for contributions in bio-medical electronics. ⁂

## C-W Aims to Recoup With Missile Growth

CURTISS-WRIGHT CORP. is eyeing a bigger share in the military missile business with hopes that it will bolster a sagging sales and profit record.

The company suffered a drop in sales of almost $60 million and $4 million in earnings from 1959 totals. During 1960, sales were $270.6 million; earnings were $10 million.

Since May, 1960, when T. Roland Berner became Curtiss-Wright president, the company has channeled its business away from air-breathing engines towards missile components, electronics and the industrial tool field. Two divisions have been sold—The Curon Division, manufacturer of foamed plastic products, and the Santa Barbara Division, engaged in production of a variety of products which were then transferred to other divisions.

At the same time, C-W has been working to increase its electronics production. Negotiations are underway to develop two new sources of components—a new engineering area at the Electronics Division's main plant at East Paterson, N.J., and a new plant under construction at Albuquerque, N.M.

The company also has received new orders for *Minuteman* and *Pershing* rocket motor cases, extruded missile launching rails for *Titan* and *Atlas* and other components for aerospace vehicles. In addition, it has been producing nuclear rod controls for *Polaris* class submarines and extruded "T" sections for the Navy. ⁂

## Services Ordered to Hike Small Business Contracting

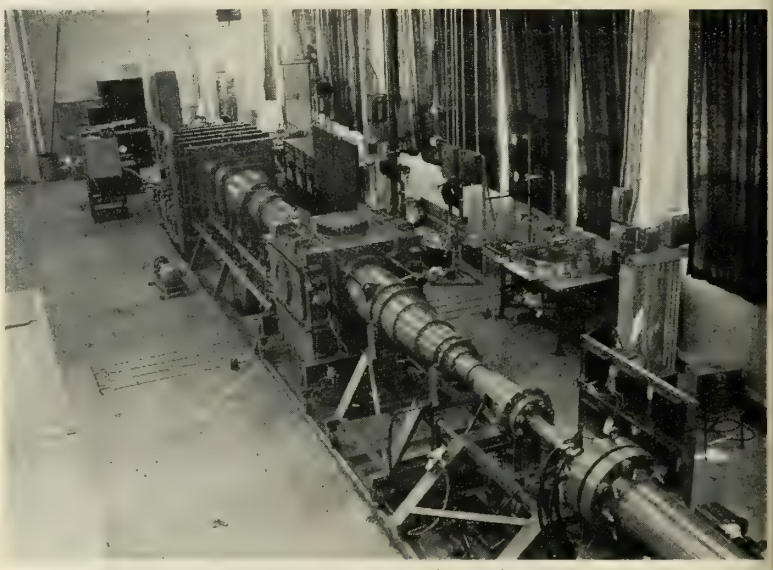
THE ARMED SERVICES have been told to give small business defense contractors a 10% increase in prime contract money in Fiscal 1962 over that given in 1960.

The order was issued to the three service secretaries by Deputy Defense Secretary Roswell Gilpatric.

The services were also directed to halt the "downward trend in small business awards reflected in the statistics for the first half of Fiscal 1961." They were asked to take action that would attempt to show an increase in fiscal 1961 small business contracting over fiscal 1960.

For the first half of FY '61, 15.5% of the total money value of all prime contract awarded went to small business, down from the 16.1% listed for the first half of FY '60.

A special Subcommittee on Defense Procurement has been re-established by the Joint Congressional Economic Committee. Sen. Paul Douglas (D-Ill.) has been reappointed chairman. ⁂



*A CONTINUOUS FLOW Mach 14 wind tunnel is under test at Air Force Research Division's Aeronautical Research Laboratory, Wright-Patterson AFB, Dayton, Ohio. Constructed for basic research, the facility when fully operational will be able to sustain a five-minute flow of high-temperature air, giving a Reynolds number up to $10^6$. Sections of tunnel from front to rear of picture: heater, nozzle, test chamber (with small circular window), diffuser and heat exchanger.*

**GENERAL ELECTRIC** has moved up to 1961 the completion schedule for its $30-million Valley Force Space Technology Center. The facility will have a total of 800,000 sq. ft. of floor space, a 60% increase over the original plan of 500,000 sq. ft. The center will have a Space Sciences Laboratory, a Space Environment Simulation Laboratory, headquarters and office element and other facilities for engineering, development and product design. By the summer of 1962 GE expects to have approximately 4000 employees working at the new Center.

**NORTRONICS DIVISION** of Northrop Corporation will begin construction April 1 on a $1.7-million multistory engineering and administration center for advanced research and engineering in electronic, electromechanical, optical and weapon-system support technologies. The Anaheim center is the sixth major Northrop facility development project now in progress under the company's three-year, $32-million capital investment program.

**EMERSON ELECTRIC MFG. CO.** of St. Louis has established a new Industrial Electronics Division to design and manufacture precision electronic control devices and systems for industry. The new division has obtained exclusive rights to manufacture in the U.S. industrial control equipment by Lancashire Dynamo Electronic Products, Ltd.

### *DOD Standardizing*

*The Defense Department conceded last week that there are deficiencies in its standardization program for missile parts and components. However, DOD said that "significant improvements" are under way. The following measures were cited:*

*1) Concentration of efforts in areas of highest "payoffs."*

*2) More use of industry standards.*

*3) Simplification and reduction of coordination processes.*

*4) Use of consolidated index of standardization documents.*

*5) Use of aperture cards to expedite handling of drawings.*

*6) Use of Technical Information File.*

**MERCK & CO., INC.** is planning a full-scale plant for production of epitaxial silicon wafers at Danville, Pa., site of Merck's single-crystal silicon plant.

Martin B. Judge, director of Merck's Electronic Chemicals Division, said the company is pushing construction of the silicon unit in expectation that commercial production of epitaxial devices will rise sharply by mid-year.

Merck also will build a germanium pilot plant at Rahway, N.J., site of Merck's basic materials research laboratories.

**PLANNING RESEARCH CORP.** has affiliated with Medical Nuclear Consultants, Inc., of Washington, D.C. Medical Nuclear will collaborate with PRC's biomedical research group headed by Dennis Patton, M.D. The PRC group is active in chemical, biological and radiological warfare and applying operations research and data processing techniques to medical analyses. Medical Nuclear, under President Stanley Clark, recently completed a space medicine study dealing with the entire spectrum of biological and medical problems of man in space.

# financial

**The Martin Co.**—Sales of $651 million were reported, compared with $523 million, and net earnings of $16.8 million, up from $13.3 million in the prior year. The company had a backlog of $1.026 billion at the year end, up from $900 million a year earlier.

**The Marquardt Corp.**—Sales and earnings slipped somewhat from the previous year. The company attributed lower earnings to increased expenditure in research. Last year's phase-out of the *Bomarc* engine development program accounted for most of the reduction in sales, said president Roy E. Marquardt. Sales were $65.5 million, compared with last year's $69 million, and earnings were $1.2 million compared with $1.3 million in 1959.

**Boeing Airplane Co.**—The company almost doubled its 1959 income with profits for 1960 of $24.5 million. Sales were $1.554 billion compared with sales of $1.649 billion for 1959. Increased profits were attributed to favorable developments in the commercial jet transport program. Backlog at year end totaled $2.139 billion compared with $2 billion the same time last year. Just under one-third of the unfilled orders were for missile and space programs.

# soviet affairs

By Dr. ALBERT PARRY

## How far ahead of us

are the Soviets in the man-in-space race? Last August, after orbiting and bringing back the dogs Belka and Strelka, Moscow officially claimed that the Soviets led the United States in manned-space flight by as much as three years. If the latest Red orbital success with the dog Chernushka this month is followed by an early launching and return of a Russian man, and if (as it is conceded in Washington) the first American manned orbital flight comes next fall or winter at the earliest, then our lag is actually about one year.

## A continuing Red lag in electronics training

is revealed in *Izvestia* of March 3. A dispatch from the city of Stalino in the heart of the industrial Donets Basin (in the Ukraine) declares that hundreds of computers and other electronic machines are now available in Soviet industries, "yet many of these instruments are not always used because our industries often lack men who know electronics and who can run and repair these complex installations."

Since governmental action in this area is too slow, Stalino's citizens have decided to solve the electronics gap themselves. The Regional Radio Club, on its own initiative, opened a special radio-electronic school. Three hundred applications streamed in immediately, but the school had facilities for only 100. The volunteer trainees are described as workers and engineers of the plants of Stalino, laboratory employes, and students of higher technical schools in the Stalino region whose regular curricula do not include electronics.

A longer and yet more plaintive article on the shortage of computer men and other electronics experts was published in *Izvestia* on Feb. 22. This complaint came from Tbilisi, capital of Soviet Georgia (in Transcaucasia). Here, too, complex computers stand still or are only partly used—because of the scarcity of experts. Short of training facilities in local Georgian schools, the Tbilisi authorities have requested a Moscow school to accept 36 Georgian electronics students. The Moscow school replied that it had room for only two.

## Flying saucer rumors

have at last popped up in the Soviet Union, and in quite some force. They have been officially noted, and scorned, by the Red government. A recent issue of *Pravda* printed an interview on this subject with Academician Leo A. Artsimovich, a foremost Soviet physicist specializing in nucleonics and electronics. He attacked rumors of flying saucers, allegedly seen over Russian territory, as stemming from their "prime source—the dishonest and anti-scientific data contained in reports read [at scholarly meetings] in Moscow by some completely irresponsible persons." Professor Artsimovich said that "these fantastic fairy tales were for the most part borrowed from the American press."

## Soviet Central Asian cities

in Uzbekistan and Tajikistan are, Soviet flying saucer fans maintain, the main Russian points over which such cosmic crockery has been seen. This Russian version of the saucer story insists that "little people from Venus" ride in such saucers; that, on landing in Soviet Central Asia, "they promptly scurry in all directions to look for inexpensive Oriental sweets."

From the North of Russia came a photograph, ostensibly taken of a flying saucer, which was brought to the Institute of Applied Geophysics of the Soviet Academy of Sciences. The Institute laboratory soon announced that this snapshot was "a result of an optical effect," that "such an effect can be produced artificially by any photo-amateur," and that "photos of this type can be made by the million to fool the gullible."

The government acknowledges, however, that flying saucer rumors are spreading too widely. It appeals to the populace to stop repeating them, "no matter how interesting they do seem to be."

# Boom Is On At Australia's Woomera Range

***In addition to stepped-up efforts in conjunction with British, 'diggers' aid U.S. tracking; satellite shots weighed***

**by Bernard Poirier**



*STURDY BOBBIN was early workhorse.*

A DECISION to launch satellites from Australia would create the first such site in the Southern Hemisphere. Aussie officials, awaiting results of secret studies now going on, are bracing themselves for their most active year in rocket development.

The tempo of Woomera Missile Range activity has intensified as joint Australia/United Kingdom teams prepare to test English Electric's SRBM *Blue Water*, to conduct evaluation and assurance programs for A. V. Roe's ALBM *Blue Steel* and to definitize final procedures for communicating with the first American astronaut to orbit over the range.

While expanding schedules call for increased testing of British military missiles and modifying British and Australian sounding rockets, Woomera is solidifying close operational links with United States space efforts.

In addition, multimillion-dollar equipment is being acquired to fulfill Woomera's commitments as a major space center.

Once a frontier shacktown skirting an arid plain where nomadic aborigines wandered about, Woomera has been transformed into a bustling missile town of 4500 persons and forms half the double nucleus of Australia's rocket community.

Salisbury missile depot, 285 miles to the South, is the other half of this nucleus. A former wartime munitions factory has been converted into a 6-sq.-mi. magazine, check-out and assembly area for accredited Commonwealth industrial contractors.

Here, they have ample facilities for development—laboratories, manufacturing and assembly plants plus other scientific and technical support areas. Their efforts at Salisbury culminate through experiments at Woomera.

• **Participants**—Among the top names of the British missile industry with personnel stationed down under are Elliott Brothers (London), A. V. Roe, English Electric and Ferranti.

Other prominent firms are Bristol Aeroplane (Austr.), de Havilland, E.M.I. Engineering Development (Austr.), Hunting Engineering, Saunders-Roe, General Electric (Ltd.), Sperry Gyroscope (Ltd.) and many research organizations.

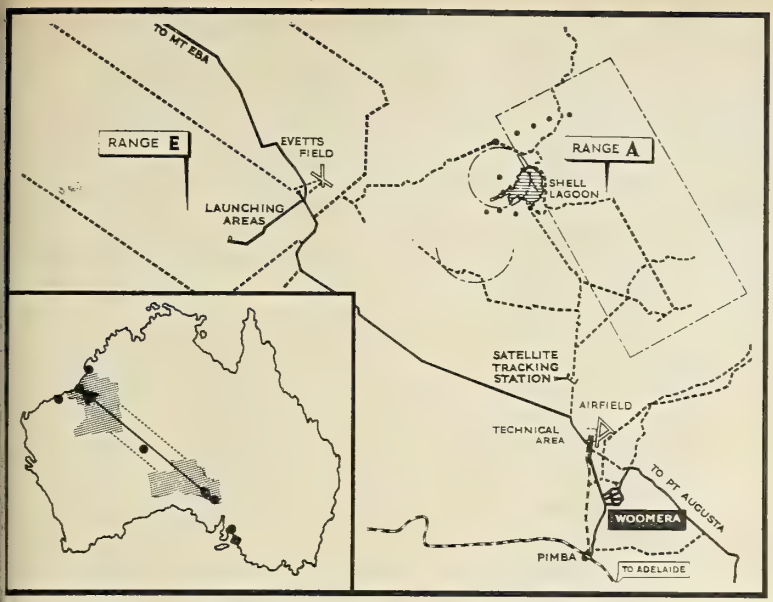
The prime difficulty facing contractors and officials is the distance between Salisbury and Woomera. Close cooperation between Controller R. W. Boswell, Chief of the Salisbury Weapons Research Establishment, and Colonel Richard Durance, Woomera Superintendent, is a requisite for smooth operations.

Australia's vast operations are best appreciated when considering the 275 mile wide shooting corridor extending 1250 miles from the environs of Woomera to Talgarno on the Indian Ocean.

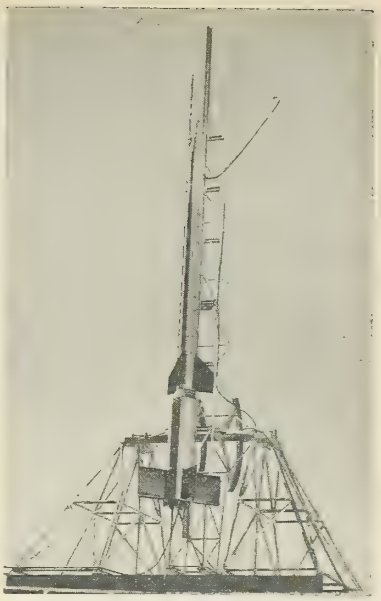
The security area around Woomera, at the southeastern end of the range, is almost the size of Oregon. No one over 16 years old enters without security clearance, and there is little chance for any spy to cross the bare, arid area without being spotted. The second security area, along the coast of the Indian Ocean, is somewhat smaller than Montana.

Launching complexes at Woomera are widely scattered and several operations can be conducted concurrently. Probably the most active complex is at Koolymilka in Range E, 25 miles north. *Skylark*, a favorite research rocket, has its launch tower here, not far from the main administration building.

One of the largest aprons and access areas had been constructed for the *Blue Streak*, now in a state of limbo and hopefully awaiting resurrection through a Pan-European Space Project. The recent Strasbourg Space proposal may be one of the cornerstones on which current secret talks for Australian satellite programs are based.




*DRAWBACK for satellite shots is NW launch angle, counter to earth's rotation.*



*AELOUS is Australia-made research bird.*

(However, it seems likely that any European space project would utilize the French Range in Algeria, thus eliminating an extra 10,000 miles transportation. Australian officials would not elaborate on other topics being covered in closed-door satellite discussions.)

Australia's role in the Space Age resulted from England's requirement for a long-range weapons testing site soon after the war. The Australian and British Ministries of Supply agreed to a joint program wherein the host provided the range and supporting facilities while Britain would supply the basic research, prototypes and production. This 1947 agreement provided an aboriginal word to the missile glossary—Woomera, meaning spear launcher. (Accent on the 'Woo').

One of the earliest birds was the versatile *Bobbin,* soon followed by predecessors to the *Bloodhound, Malkara, Blue Steel,* and *Thunderbird.* Research workhorses continue to be Britain's *Black Knight* and *Skylark* alongside Australia's *Long Tom* and *Aeolus.*

Woomera was the first major overseas NASA Satellite Tracking Station. A huge 85 ft. space probe radar dish at Island Lagoon is ample evidence of U.S. interest in Australia. The receiver is operated and maintained by an Australian crew from the Department of Supply. Technical direction of this *DSIF* (Deep Space Instrumentation Facility) is provided by the California Institute of Technology Jet Propulsion Laboratory.

Voice transmissions from the Goldstone transmitter in the Mohave Desert, California, have already been received by *DSIF,* Island Lagoon, via way of the moon. Australia will soon get its own transmitter for communication with space vehicles and American astronauts. Other satellite tracking equipment will also be added.

At Salisbury, a new IBM 7090 Computer with peripheral equipment has been added to handle increased workloads. This million-dollar rental represents just one area of Australian/British expansion programs.

The IBM installation complements the Elliott Brothers (London) Computer known as WREDAC, Weapons Research Establishment Digital Automatic Computer. This, plus Elliott's AGWAC, Australian Guided Weapons Analogue Computer, constitutes one of the largest computer installations in the British Commonwealth.

WREDAC processes research factors correlation data which require extensive programing. Peripheral input is provided by four Ampex high-speed magnetic tape units. AGWAC output can be digested by both IBM 7090 and WREDAC, particularly for further computations of simulator evaluation data for integration problems embracing whole complex weapons systems.

Much of Salisbury's rapid growth can be attributed to its own enterprise. W.R.E. made its own vacuum handling lines and associated equipment for kinetic studies such as those related to graft polymerisation of acrylate monomers on to polyisobutene.

Their own mechanical and electrical laboratories produced methods and materials for a Mach 1.4 to Mach 2.8 supersonic wind tunnel with a 4000 HP motor and is used for missile configuration and other fundamental research. Featured in the tunnel is its continuous reuse design and a 15-sq.-in. working area.

Salisbury authorities constructed a high-temperature vacuum furnace for sintering operations in connection with high-temperature metallurgical experiments—up to 2400°C and designed a unique reading mirror in an exterior mounted, aligned optical pyrometer.

Work on British vehicles is conducted by a joint U.K./-Australian Trials and Instrumentation Wing. A smaller unit, Weapons Research and Development Wing, undertakes programs of purely Australian concept.

Overseeing Australian operations are Alan S. Hulme, Minister for Supply, and his Deputy Chief Scientist. Both maintain offices in Melbourne.

Current top-priority projects, besides *Blue Water* and *Blue Steel* programs, are investigation of faster, more complex data processing, VHF and microwave engineering up to 40,000 Mc/S, optics and command guidance.

While Australia is successfully carving its niche among space-conscious nations, a few down-to-earth problems reminiscent of tales related by American range officers remain to be resolved. Dingoes (wild dogs) and Galah parrots have been problems. A dingo kills sheep for the joy of something to do and Galahs have the reputation of eating through communication lines. More embarrassing are the kangaroos who, at times, are counted by the dozen prancing down a Woomera street. ⁂


Research
And
Engineering
For
MAN IN SPACE
M/R's special issue covering the research and engineering phase of Man in Space is extremely important and timely... will be read and re-read by M/R's space-oriented audience of over 31,555* paid subscribers.
*Subject to audit
MISSILES AND ROCKETS
MAY 29, 1961
CLOSING DATE MAY 8
Materials
Boosters
Electronics
Space Medicine
Re-entry




## Solid-State Current Drivers

Two new completely solid-state current drivers suitable for driving thin film and magnetic core memories will be introduced by Digital Equipment Corp.

The Negative Current Driver Type 52 and the Positive Current Driver Type 62 feature a current range of 0.1 to 1.0 amperes and ±50 volts back voltage. Rise and fall times are 0.05 to 0.5 microsecond. Output impedance is greater than 2000 ohms at 1 ampere. Each of the compact units is only 10.5 in. high, 10.5 in. deep, and 2.5 in. wide. Seven drivers can be mounted in only 10.5 in. of vertical space in a standard 19-in. rack panel.

Circle No. 225 on Subscriber Service Card.

## Glass-To-Metal Seals

Seal-A-Metic has perfected a "Moleculoc Sealing Technique," encompassing not only a modified fusing method, but also a new hardening process, and a new method of processing terminal pins that more than doubles their ability to withstand bending. Several new quality control checks have been instituted that cull all but the perfect seals.

Circle No. 226 on Subscriber Service Card.

## Transport Delay Simulator

A transport delay simulator, a true RMS voltmeter and two X-Y recorders are among the electronic instruments and systems to be introduced by F. L. Moseley Co.

The Model TD-5 transport delay simulator easily reproduces any time delay encountered in a process control or experimental laboratory situation. The system combines a standard Autograf Model 2D X-Y Recorder with its roll chart accessory and a Moseley Type F-2 Optical Line Follower carried on the recorder's second arm. Any function can be recorded by the recorder's writing pen and, at any desired time later, can be read back by the line follower. Readout, a varying voltage always proportional to the Y coordinate of the recorded curve, can be used for control purposes.

Circle No. 227 on Subscriber Service Card.

## Magnetostrictive Delay Lines

Deltime, Inc., will demonstrate resolutions and capacities of magnetostrictive delay lines.

Basically, the demonstration will consist of a word generator, a Deltime Type 192 magnetostrictive delay line, and a visual read-out. Various words of varied bit lengths will be generated, fed through the Deltime 192 line, and displayed to illustrate the resolution and capacity of the magnetostrictive delay line.

Circle No. 228 on Subscriber Service Card.

## Epitaxial Transistors

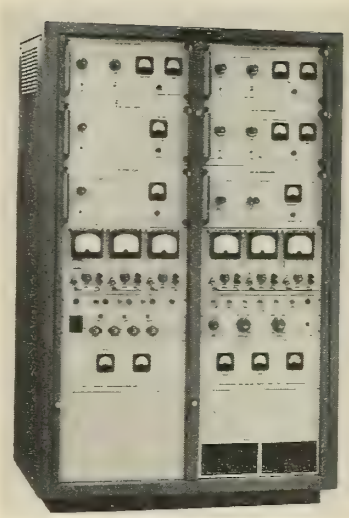
Silicon and germanium epitaxial mesa transistors will be featured by Motorola Semiconductor Products Inc.

The epitaxial devices, both switch and amplifier types, are electrically equivalent to micro-alloy types, but retain the high-power capability and high-reliability facets normally associated with mesa-type transistors.

In power transistors, Motorola is introducing its complete TO-3 (diamond) package transistor line in a new "low silhouette" type container. The package makes possible valuable space-saving advantages in printed circuit board sandwich-type equipment.

Circle No. 229 on Subscriber Service Card.





## Calibration Test Set

An RF calibration test set, a plug-in element for bi-directional power monitors, a transistor tester and a frequency selective voltmeter with carrier reinsertion are among the new electronic equipment to be introduced by Sierra Electronic Corp.

The calibration test set provides an accurate, stable source of RF power for the calibration of RF power measuring equipment.

The plug-in element for Sierra bi-directional power monitors covers a frequency range of 70 to 470 MC. Its full scale ranges are 50, 100, 500 and 1000 watts. The unit is temperature-compensated and its stability is within 5% over the ambient temperature range of 15°C to 40°C.

Circle No. 230 on Subscriber Service Card.

## Potentiometers and Resistors

International Resistance Co. will show its latest product developments in its resistor and potentiometer lines.

These include 1/10 watt molded deposited carbon resistor, epoxy-coated deposited carbon and metal film resistors, multi-turn and precision potentiometers and Revodex dials.

Circle No. 231 on Subscriber Service Card.

## Wideband Microwave Device

Sylvania Electric Products Inc. is marketing SB-100, a wideband microwave device which promises to simplify the circuitry and improve the sensitivity of communications links, long-range



radar and other microwave equipment. The coaxial component acts as a bandpass from 2.5 megacycles to 11,000 megacycles while isolating frequencies from dc to 2.5 megacycles. The bandwidths of conventional dc blocks provide isolation from only 1000 to 8000 megacycles, 2000 to 10,000 megacycles of 4000 to 13,000 megacycles.

Circle No. 232 on Subscriber Service Card.

## Double-Ended Transistors

A line of double-ended subminiature silicon NPN transistors are available from Raytheon Co.

The first double-ended subminiature transistors available, the seven electrically-welded, hermetically-sealed subminiatures are the 2N902 through 2N908. Capable of dissipating 400 milliwatts at 25°C, they are electrically equivalent to the single-ended subminiatures 2N789 through 2N793, 2N745 and 2N746, and to the single-ended TO-5 units, 2N332 through 2N338.

Circle No. 233 on Subscriber Service Card.

## Measurement Instruments

Thirty-three instruments for making time-saving electronic measurements will be introduced by Hewlett-Packard Co. The basic function of these precision instruments is to produce and to measure electrical quantities such as voltage, current and frequency. With proper transforming devices, they also measure flow, pressure, speed, RPM and other common manufacturing and processing quantities.

Circle No. 234 on Subscriber Service Card.

## Miniaturized Power Packs

Electronic Research Associates, Inc., will display additions to their Transpac line of solid-state miniaturized high-current power packs. These units which are designated as the TR-4R and TR-8R Series provide highly regulated DC outputs at all battery voltages at current ratings of 4 and 8 amperes and supplement the existing line of 2 ampere units.

These units are intended to replace battery or laboratory sources of power and to be wired permanently into equipment to supply check-out equipment, transistorized devices and related applications.

Circle No. 235 on Subscriber Service Card.

## Portable Oscillographs

Portable oscillographic recorders are available from the Sanborn Co. The Model 320 two-channel direct writer occupies approximately a cubic foot, yet provides broad DC recording capabilities. Two other versions of the Model 320 will also be displayed: Model 321 carrier type, and Model 322 low gain DC recorder including zero suppression. Brief-case-size one-channel direct writers will be featured—Model 299 for general purpose DC recording, and the Model 301 Carrier.

Circle No. 236 on Subscribed Service Card.

## Ceramic Transducers

High-voltage-producing "PZT" piezoelectric ceramic transducers are available from Clevite Electronic Components division of Clevite Corp.

The electromechanical transducers are similar to those powering the "Spark Pump," the piezoelectric ignition device developed by Clevite.

Also displayed will be ceramic transducer elements for sonar, ultrasonic cleaning and measuring; ceramic i-f filters and self-generating accelerometers.

Circle No. 237 on Subscriber Service Card.

# new literature

MULTI-SPINDLE AUTOMATICS—A comprehensive Job Portfolio illustrating, complete with all technical details, efficient metal-cutting jobs run on W&S Multi-Spindle Automatics, has just been published by Warner & Swasey Co. The booklet contains a wealth of information on dozens of different workpieces and tooling applications. Each job is illustrated with dimensioned line drawings and complete setup sheet data. By comparing this information with jobs of similar shape and size in your own shop, many new ideas and methods for improving your machining operations can be gained.

Circle No. 200 on Subscriber Service Card.

SELECTIVE PLATING—Selectrons, Ltd., has published a four-page booklet listing varied industrial uses and advantages of a high-speed selective plating process. Typical engineering applications in the electronics, aircraft and missile, marine, machine tool, and gravure industries are included. The booklet also contains a chart indicating deposition rates, metal concentrations, and recommended current densities.

Circle No. 201 on Subscriber Service Card.

RATE GYROS—A concentrated engineering discussion on angular velocity sensors of a rate gyroscopic type is presented in The Rate Gyroscope, a 55-page copyrighted publication of R. C. Allen Aircraft Instrument Division, R. C. Allen Business Machines, Inc. Its general divisions are Rate Gyro Engineering Theory, Rate Gyro Engineering Applied, Rate Gyro Testing and Rate Gyro Terminology. It helps lay a foundation for standardization of the measure of Rate Gyroscope performance.

Circle No. 202 on Subscriber Service Card.

CAPACITOR DATA—Reliability test data accumulated on over 100,000 capacitors since 1930 are released in a manual prepared by John E. Fast & Co. This manual records the story of a 30-year search for capacitor reliability, illustrated with distribution curves of data on breakdown studies. It examines such parameters as voltage, temperature, frequency, insulating materials, and area of windings. The new manual discloses how life, capacitance and leakage current are affected over extended temperature ranges.

Circle No. 203 on Subscriber Service Card.

RECORDING VOLTMETER—Specifications and description of Model 1122-B-60 Expanded Scale Recording Voltmeter are available in a 2-page illustrated catalog sheet issued by Brenner-Fiedler & Associates, Inc. The literature gives details and operating advantages and compares voltage charts recorded by the Brenner-Fiedler unit with charts recorded using a rectifier voltmeter and a dynamometer voltmeter. Specifications provide complete information on ranges, accuracy, controls, power connections, sizes and weight.

Circle No. 204 on Subscriber Service Card.

STRAIN GAGES—A technical paper on Recent Developments in Flexible Silicon Strain Gages, authored by Dr. William V. Wright of Electro-Optical Systems, Inc., and J. C. Sanchez of Micro Systems, Inc., is available from Micro Systems Inc. The paper discusses the properties of semiconductor silicon strain gages and stresses high gage factors coupled with reasonable temperature stability. Applications of the semiconductor devices in aircraft instrumentation and physiological measurements are presented.

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# contracts

## NASA

$555,075—**California Computer Products, Inc.**, Downey, for production of the control system for a series of seven *Nimbus* satellites.

$163,040—**The Martin Co.**, Baltimore; $148,487—**North American Aviation**, Downey, Calif.; $115,565—**Convair Astronautics**, San Diego; for design studies of launch vehicles having two to three million pounds thrust in the first stage.

$103,000—**Vitro Electronics, a division of Vitro Corp. of America**, for 34 multiple-bandwidth receivers and 36 preamplifiers for use in the *Centaur* program.

$66,000—**Stauffer Chemical Co.**, New York City, for research and development of high-temperature-resistant polymeric film forming material.

## MISCELLANEOUS

$1,924,139—**R. J. Daum Construction Co.**, Hawthorne, Calif., for construction of operating and support buildings and facilities at the Atomic Energy Commission's Nevada Test Site, Las Vegas.

## NAVY

$20,000,000—**General Electric's Ordnance Department**, for advanced *Polaris* fire control systems.

$5,534,526—**Remington Rand Univac Military Department**, St. Paul, Minn., for production of additional computer systems for the Naval Tactical Data System.

$1,300,000—**The Bendix Corp., Bendix-Pacific Division**, follow-on from **Convair-Pomona** for electronic portions of *Terrier* missile guidance system.

$1,000,000—**Maxson Electronics Corp.**, New York City, for *Bullpup* guidance and components.

## ARMY

$5,361,619—**Ford Motor Company's Aeronutronic Division**, Newport Beach, Calif., for continuation of development of the *Shillelagh* missile.

$2,141,000—**Chrysler Corp.**, Detroit, for continued installation and checkout requirements for the *Jupiter* missile system overseas.

$1,980,972—**Western Electric Co.**, Winston-Salem, N.C., for engineering documentation of the *Nike-Hercules* air defense system.

$1,500,000—**Temco Missiles & Aircraft, division of Ling-Temco Electronics, Inc.**, for manufacture of erector-launchers for the *Sergeant* missile.

$950,000—**Sperry Rand Corp.**, Salt Lake City, for research and development on the *Sergeant* missile system.

$858,620—**J. W. Fecker Division, American Optical Co.**, Pittsburgh, Pa., for cinetheodolite.

$650,987—**Raytheon Co.**, Waltham, Mass., retrofit kits and concurrent repair parts for the *Hawk* guided missile system. Two contracts.

$434,389—**Jordan Electronics Division, The Victoreen Instrument Co.**, Cleveland, for additional guidance power supplies for the *Sergeant* missile system. Subcontract from **Sperry Rand Corporation.**

$92,160—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for research and development on improved *Honest John* rocket system.

$56,353—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for *Nike* repair parts.

**Daniel, Mann, Johnson & Mendenhall, Systems Division**, Los Angeles, for the data-handling system design for Project *ARTRAC* at White Sands Missile Range. Range instrumentation, data handling, and control will be integrated into a single unified system. No amt. disclosed.

**Weston Hydraulics, Ltd.**, Van Nuys, Calif., for development of an electro hot-gas servo valve for the *Mauler* missile. No amount disclosed.

## AIR FORCE

$2,000,000—**The Geotechnical Corp.**, Garland, Tex., for seismographic stations for Project *Vela*.

$1,500,000—**Ling-Temco Electronics, Inc.'s Temco Overhaul and Aerosystems Division**, Greenville, Tex., for modification of C-130A transports to accept instrumentation equipment including equipment for tracing the *Polaris* missile.

$600,000—**Texas Instruments, Inc.**, Dallas, for the development and production by the **Apparatus Division** of electronic flight controls for use in the *Titan ICBM* and *Scout* research vehicle. Two contracts.

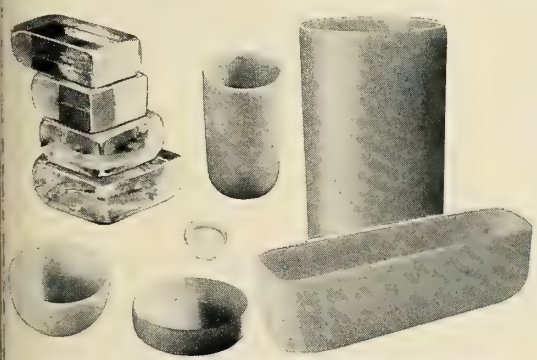
$250,000—**Leach Corp.**, Compton, Calif., for audio intercommunication systems for the *Hound Dog* missile program. Subcontract from **North American Aviation, Inc.**

$173,400—**Boeing Airplane Co., Aerospace Division**, Seattle, for technical data applicable to the *IM99A* and *IM99B* missile. Three contracts.

$124,850—**Thiokol Chemical Corp.**, Brigham City, Utah, TUX-1S140 ignition systems for M16E3 rocket motors.

$122,750—**Vitro Electronics, division of Vitro Corp. of America**, for telemetry receiving systems at the Missile Test Center, Patrick AFB, Fla.

$90,000—**The Martin Company's Electronics Division, Baltimore**, for development of a cryogenic delay line.

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# names in the news


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SHAW

**James N. Davis:** Appointed to newly-created position of Deputy Assistant Secretary of Defense for Production Management, which includes responsibility for product leadtime and decision making. Since February, 1960, he has been vice president of the Bell Aerosystems Co., Buffalo, N.Y., also serving as manager of the aerospace and rocket operations. From 1957 to 1960 he was vice president for Government operations for Vertol Aircraft Corp., Morton, Pa.

**Imre Farkass:** Appointed director of applied physics for Ilikon Corp., Natick, Mass. A leading authority on ultrahigh vacuum technology, he is the creator of the "Farkass chambers" used in ultrahigh-vacuum research and space simulation testing.

**Walter B. Brewer, Jr.:** Appointed assistant general manager of the Engineering Division of Aerospace Corp., El Segundo, Calif. Prior to joining Aerospace, he was study director, Advanced Systems, and manager of the Atlas Airborne Systems Department at Space Technology Laboratories, Inc.

**Edmund M. Velten:** Promoted to vice president-production of The Beryllium Corp., Reading, Pa. Formerly general manager of the company's Nuclear Division in Hazleton.

**Edward D. Weisert:** Joins the Research Department at Rocketdyne Division of North American Aviation, Inc., Canoga Park, Calif., where he will research materials and processes associated with advanced rocket engine requirements. Prior to joining Rocketdyne, he supervised materials research activities at The Marquardt Corporation and at the Metals Research Laboratory of Union Carbide Metals Company.

**George B. Shaw:** Elected vice president of ACF Industries, Inc., and will continue as general manager of the Electronics Division at Riverdale, Md.

**Dr. Louis A. Carapella:** Joins the Research Division of General Dynamics Electronics. He formerly was with the Sylvania-Corning Nuclear Corp., Bayside, N.Y.

**Charles E. Heitman, Jr.:** Elected vice president and member of the administration committee of The Bendix Corp., Detroit. He will continue to serve as group executive in charge of the Products Division, South Bend, Ind. **Dr. John A. F. Gerrard** appointed director of electronics engineering for the Pacific Division, North Hollywood, Calif. Formerly a consultant to the President's special assistant for technology and a member of the President's panel on seismic improvement, he also has served on the Defense Department committee on detection of nuclear explosions.

**Dr. Daniel Binder:** Former physicist with Oak Ridge National Laboratory, joins Hughes Aircraft Company's nuclear electronics laboratory as head of the nuclear measurements department.

**William M. Smith:** Appointed vice president and manager of Bell Aerosystems Company's Aerospace Rockets Division. Smith has served in engineering and management capacities with Bell for over 20 years. **Frank H. Andrix:** Named assistant vice president and will continue as director of engineering for the company's Avionics Division.

**William Donner Roosevelt:** President of Colorado Investment & Development Corp., Denver, and also manager of operations there for Standard Products, Inc., elected a director of Electronic Communications, Inc., St. Petersburg, Fla. He is a grandson of the late President Franklin Delano Roosevelt.

**Donald W. Cotch:** Appointed to staff of Aircraft Armaments, Inc., Plans and Programs Division to serve as Huntsville, Ala., representative providing liaison with the Army Rocket Guided Missile Agency, Army Ballistic Missile Agency, and Marshall Space Flight Center. Prior to joining AAI, he was a staff engineer with Chrysler Missile Division.

**Dr. Charles E. Montgomery** and **Dr. Leonard G. Abraham, Jr.:** Appointed research physicist and engineering specialist, respectively, at the Applied Research Laboratory of Sylvania Electric Products, Inc., Waltham, Mass. **Gerald E. LaRochelle** named manager of the Muncy, Pa. plant of the Computer Products Operations, and **Harold A. Murphy** named manager of contracts at the Systems Engineering and Management Operation, Needham, Mass.

**Philip F. Fahey, Jr.:** Former chief of Technical Support Division, Directorate of Rocket Propulsion, Edwards AFB, joins the technical staff of Lockheed Aircraft Corp., California Division, Spacecraft Group.

**Dr. Jerome B. Wiesner:** President Kennedy's special assistant for science and technology, named by the EIA board of directors to receive the 1961 EIA Medal of Honor for "distinguished service contributing to the advancement of the electronics industry." Dr. Wiesner is now on leave as director of the Research Laboratory of Electronics at MIT and is the first government official to be selected for this award since its establishment in 1952.

**Frank L. Dobbins:** Director of Material, Boeing Airplane Company, elected chairman of the Aerospace Industries Association Materials Procurement Committee.

**Dr. Bernard E. Kalensher:** Joins Electro-Optical Systems, Inc., Pasadena, Calif. as a senior physicist in the Fluid Physics Division, where he will perform analytical work connected with space and laboratory testing of ion and plasma propulsion devices. Prior to joining EOS, Kalensher was a senior research engineer at Jet Propulsion Laboratory.

**Ralph G. Lindstrom:** Appointed manager, Engineering Services Department for the Western Development Laboratories of Philco Corp., Palo Alto, Calif. Prior to joining Philco, Lindstrom was supervisor of engineering services for Lockheed Aircraft Service, Ontario, Calif., and has been associated with Farnsworth Electronics Co. and Associated Missile Products Corporation.

**Dr. Morris Handelsman:** Promoted to associate director of advanced military systems, Defense Electronics Products, Radio Corporation of America, Camden, N.J. For the past two years, he has been a member of the technical staff of AMS.

# when and where

## MARCH

**British Interplanetary Society, Rocket Motor Technology,** Birmingham, England, Mar. 30.

## APRIL

**Instrument Society of America, 7th National Aerospace Instrumentation Symposium, co-sponsored with Southern Methodist University,** Fort Worth, Tex., April 1-4.

**International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Institute of the Aerospace Sciences, AFOSR, ONR, U.S. Army Signal Corps.,** Auditorium of the Engineering Societies Bldg., New York City, April 4-6.

**American Rocket Society, Lifting Re-entry Vehicles: Structures, Materials and Design,** Palm Springs, Calif., April 4-6.

**Society of Automotive Engineers, 1961 National Aeronautic Meeting,** New York City, April 4-7.

**American Society for Testing Materials, Symposium on Materials and Electron Device Processing,** Benjamin Franklin Hotel, Philadelphia, April 5-7.

**Institute of the Environmental Sciences, Annual Meeting and Equipment Exposition,** Sheraton Park Hotel, Washington, D.C., April 5-7.

**American Institute of Chemical Engineers, Management Engineering Conference, sponsored with AIEE, ASME, IRE, AIME,** Statler Hilton Hotel, New York City, April 6-7.

**ASME Maintenance and Plant Engineering Conference,** Bancroft Hotel, Worcester, Mass., April 10-11.

**The Combustion Institute, Western States Section, Aeronutronic Division of Ford Motor Co.,** Newport Beach, Calif., April 10-11.

**Cincinnati Sections of the Society for Applied Spectroscopy and Instrument Society of America, Symposium,** Cincinnati Gardens, Cincinnati, April 11-12.

**Air Force Office of Scientific Research, Conference on Ultrapurification of Semiconductor Materials,** New England Mutual Hall, Boston, April 11-13.

**Symposium on Information and Decision Processes,** Purdue University, Lafayette, Ind., April 12-13.

**Cincinnati Section IRE, with Southern Ohio Section of American Rocket Society, 15th Annual Spring Technical Conference, Electronic Data Processing,** Hotel Alms, Cincinnati, April 12-13.

**Institute of the Aerospace Sciences, Army Aviation Meeting** (classified), Washington, D.C., April 13-14.

**Seventh Military Operations Research Symposium, ONR, at Boeing Airplane Co.,** Seattle, April 17-19.

**Seventh National Instrument Society of America, Symposium on Instrumental Methods of Analysis,** Shamrock-Hilton Hotel, Houston, April 17-19.

**Symposium on Chemical Reactions in the Lower and Upper Atmosphere,** Stanford Research Institute, Mark Hopkins Hotel, San Francisco, April 18-20.

**American Geophysical Union and American Meteorological Society, Annual Meeting,** National Academy of Sciences, Washington, D.C., April 18-21.

**13th Annual Southwestern Institute of Radio Engineers, Conference and Electronics Show (SWIRECO),** Dallas Memorial Auditorium, Dallas, April 19-21.

**American Society of Mechanical Engineers, Metals Engineering Conference, sponsored with American Welding Society,** Pennsylvania Sheraton Hotel, Pittsburgh, April 23-26.

**Symposium on Structural Dynamics of High Speed Flight (confidential), Aerospace Industries Association and Office of Naval Research,** AIA Auditorium, Los Angeles, April 24-26.

**Aerospace Medical Association, Thirty-second annual meeting,** Chicago, April 24-27.


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Agency—D'Arcy Adv. Co.
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Agency—J. Walter Thompson Co.
Autonetics, a Div. of North American Aviation, Inc. 18
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Agency—Stuart Sande, Adv.
Food Machinery & Chemical Corp., Ordnance Div. 8, 9
Agency—The McCarty Co.
General Electric Co., Silicone Products Dept. 7
Agency—Ross Roy-B.S.F.&D., Inc.
Kaynar Mfg. Co., Inc. 51
Agency—J. M. Straus & Co.
Kollmorgen Corp. 33
Agency—Wilson, Haight & Welch, Inc.
Lockheed Aircraft Corp., Georgia Div. 32
Agency—Foote, Cone & Belding
Reinforced Plastics, Dept. of Raybestos Manhattan, Inc. 10
Agency—Gray & Rogers, Adv.
Remington Rand UNIVAC, Div.-Sperry-Rand Corp. 6
Agency—Mullen & Assoc., Inc.
Sigmund Cohn Corp. 11
Agency—William G. Seidenbaum & Co.
Thiokol Chemical Corp., Rocket Div. 35
Agency—Hicks & Greist, Inc.
Vickers Inc., Div.-Sperry-Rand Corp. 36
Agency—Gray & Kilgore, Inc.
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# Two Steps toward Space Sanity

ADMINISTRATION officials have taken two important steps recently to strengthen the Air Force for the increasingly important role it must play in space.

First is the McNamara directive clearly establishing the Air Force as the Nation's military space agency. This is, in one sense, merely recognition of a situation that already exists. Some 90% of military space funding is under Air Force direction.

But its true importance lies in the direction it provides for the future. By clear assignment of responsibility, the Administration has cleared the path for development of a military space capability.

This potential must be realized as rapidly as possible. We cannot afford to lag behind the Russians in this vital area.

Fuzzy thinkers can come up with a dozen reasons why military space systems are neither practical nor important. Well-intentioned liberals can confuse the issue with pious laments that both the U.S. and the Soviet Union should keep their military out of space. Rubbish!

In every air war we have fought, U.S. pilots have been forced to look up at the enemy. In the last one, in Korea, they were looking up at the bottom of Russian-built aircraft.

We cannot allow it to happen again. If the day ever arrives when our military men face a Russian space force they cannot match, we can write off our nation as an effective power on this earth or elsewhere. The peace of the world hangs on our ability and capability to maintain at least a military balance with communist forces of whatever type.

First step must be development of large liquid and solid boosters to support the necessary military space programs. There has been enough talk about how well we are doing in microminiaturization of payloads. It's about time we had some maxomajorization of engines.

With assignment of virtually total authority over space research and development to the Air Force goes considerable responsibility. The Air Force must be certain Army and Navy needs in this area are met. It must be willing to relinquish authority in areas where the Army or Navy more logically should have primary control.

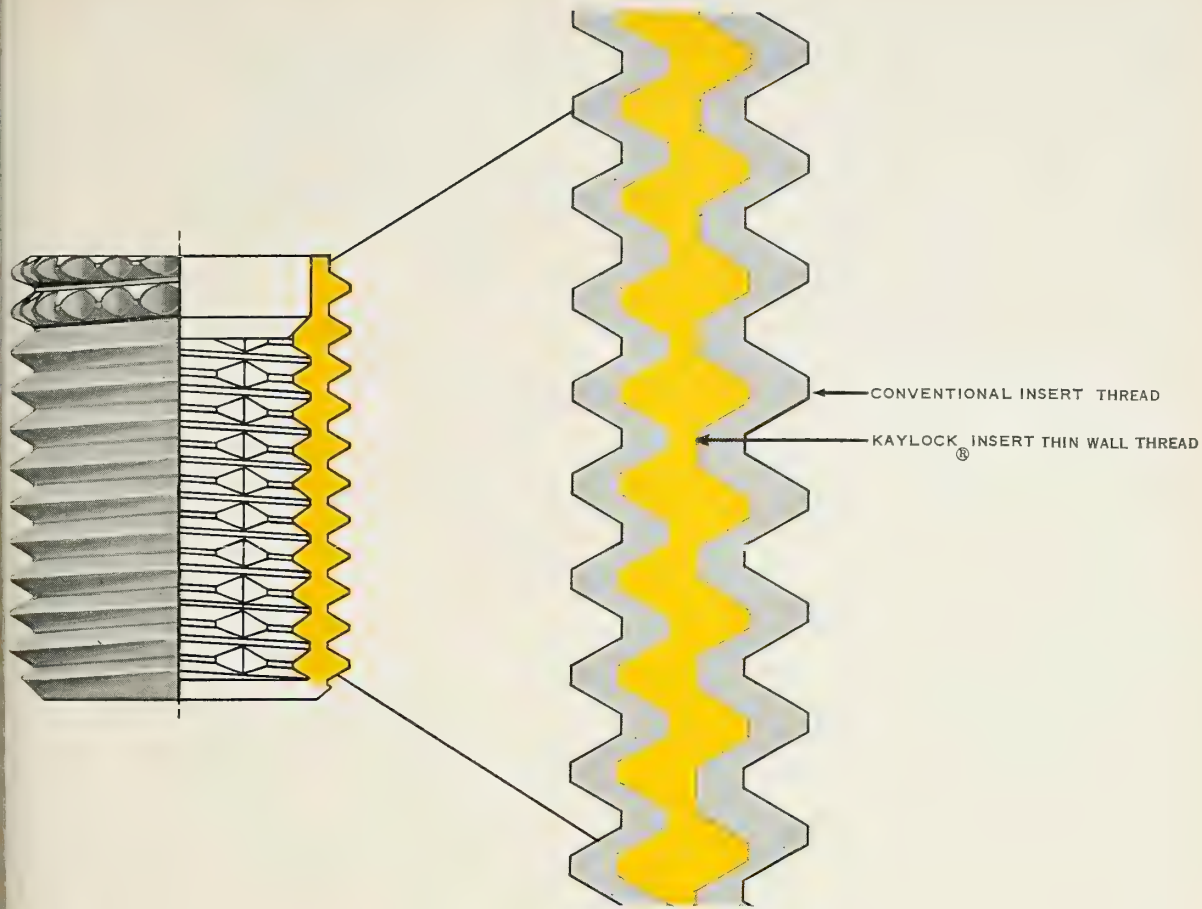
The McNamara directive clarified the mission. The second important step toward a sound space approach is the management reorganization of the Air Force which has just been announced.

THIS HAS LONG been needed. Lines of command between Ballistic Missile Division, Ballistic Missile Center, AMC, ARDC, Wright-Patterson, SAC and AF headquarters have been so tangled, it is a wonder the ballistic missile programs have moved as well as they have. Even the names were confusing. Many have wondered, for example, just where space systems development fit into something called a ballistic missile division. Basic research, for which ARDC initially was established, often was overlooked as these empires grew. Much of what was accomplished was achieved by capable officers who simply cut across confused command channels.

Establishment of the Air Force Systems Command under Gen. Schriever will straighten out this tangled web of authority and responsibility. Sorting out of programs and personnel into a Ballistic Systems Division, a Space Systems Division, an Aeronautical Systems Division and an Electronics Systems Division makes excellent sense.

We applaud Department of Defense and Air Force officials for setting our space effort off in the right direction under a sensible management program. We hope it now receives the financial support it requires.

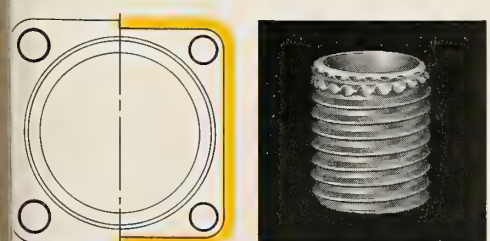
**William J. Coughlin**




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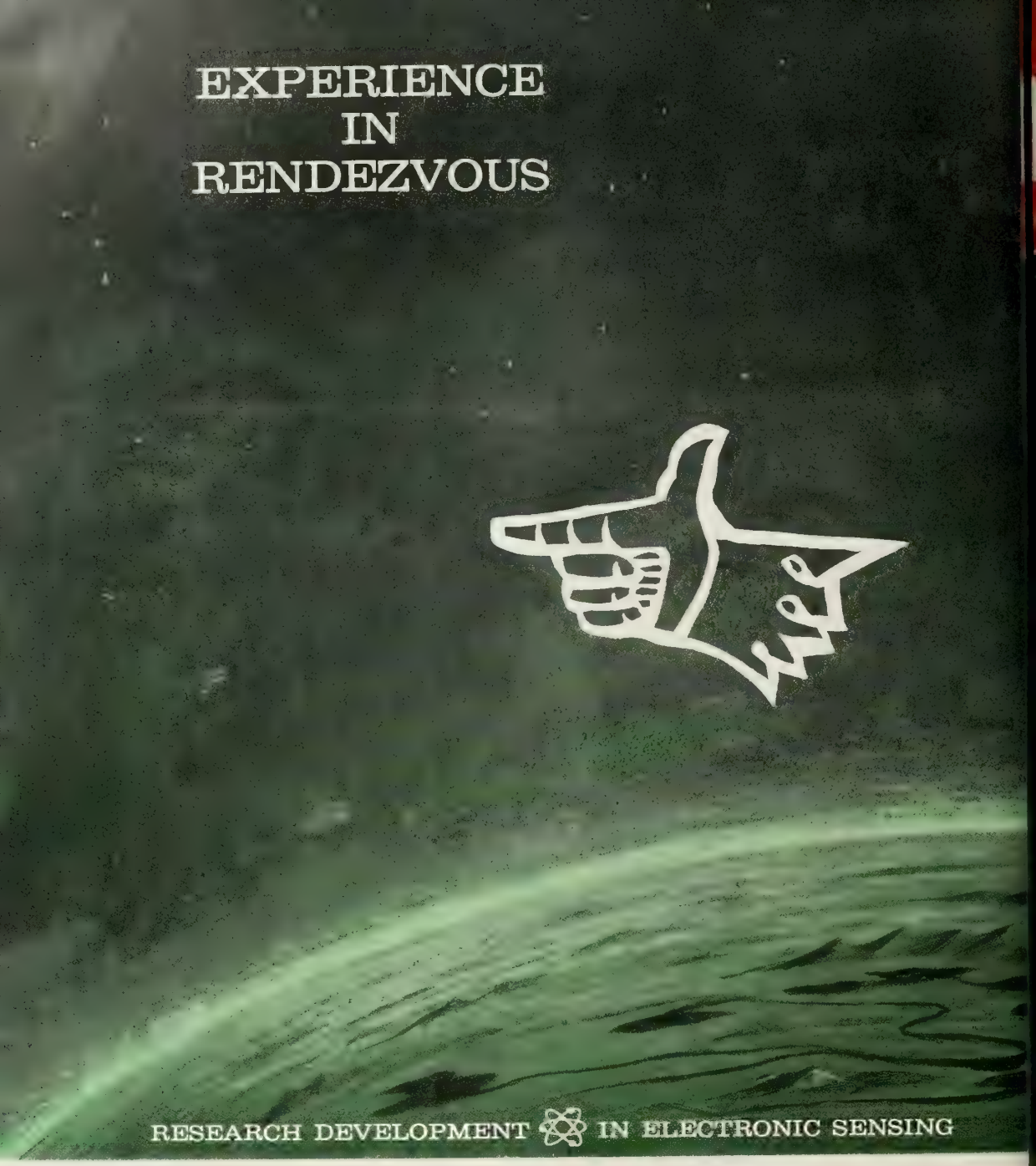


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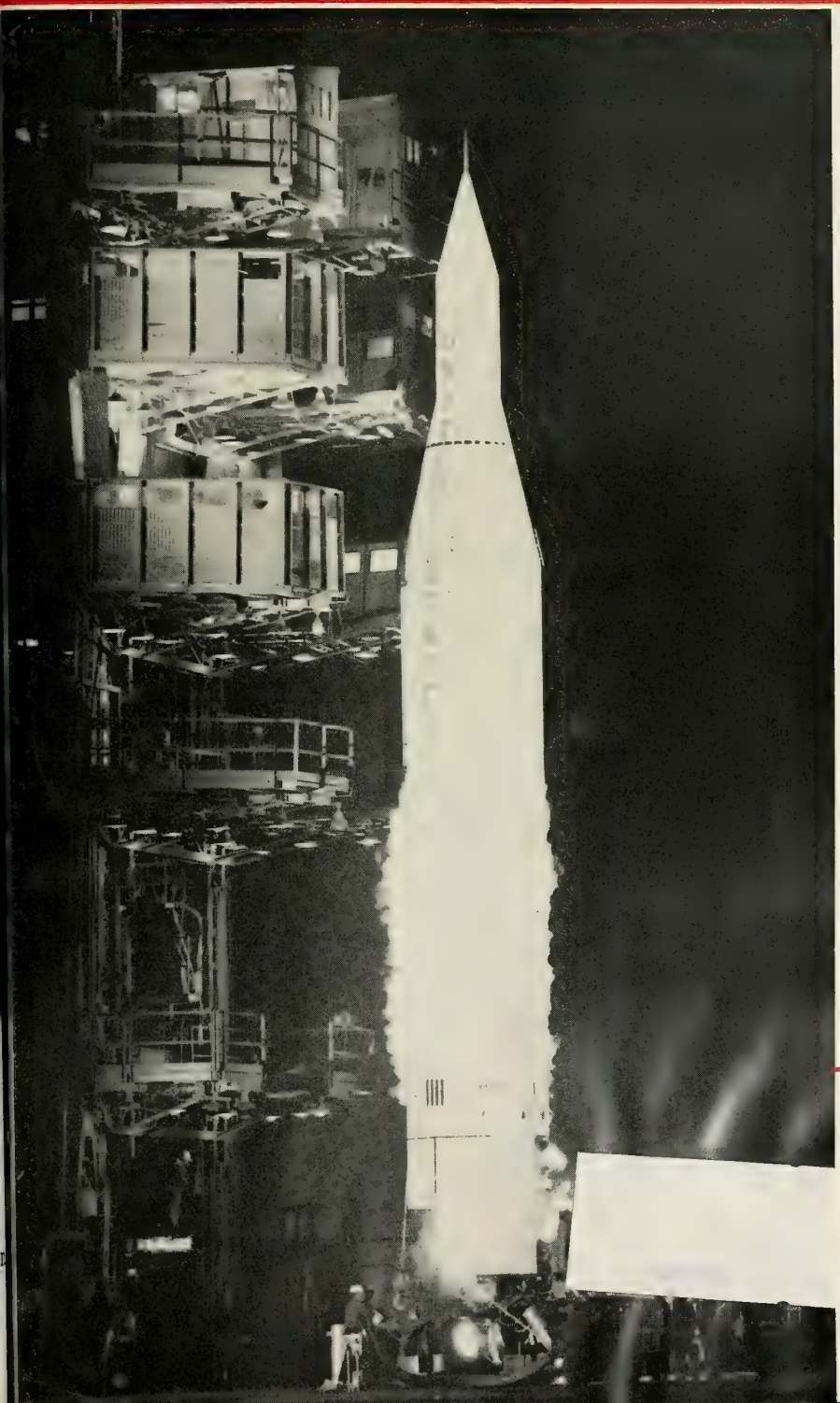
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APRIL 3, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY



## JFK Asks Big Polaris Build-up— Shuns DOD Space Plans

- **Funds to Aid NASA Boosters**
- **Breakthrough For Beryllium**
- **F-1 Engines Tests to Start**

*S-15 Near First Launching*

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Space-Age Project "NEW MOLECULES"

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# Monsanto Research Corporation . . . mapping pathways to unique molecules that solve difficult military and industrial problems

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The Monsanto Research Corporation conducts research and development programs to produce special new materials to fit specific requirements. This laboratory focuses the scientific resources of a major chemical company on creating special molecules. Here, basic science and applied technology in organic, inorganic, polymer and petroleum chemistry are integrated in the creative expedition.

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**SOLID PROPELLANTS . . .**

for the Bureau of Naval Weapons, exploring complete new types of solid propellants. As a creator, developer and producer of commercial chemicals, Monsanto's studies are directed at altogether new chemical systems of energy release for solid core rockets.

**HULL-VIBRATION DAMPING . . .**

for the Navy, Bureau of Ships, developing plastic coatings to damp vibration of metal parts. Study has developed a mathematical formula that relates actual engineering damping to fundamental constants of the polymers. Developed to date: a series of compounds that promise to be twice as effective as any previously known.

**HIGH-HEAT-STABLE FLUORINE COMPOUNDS . . .**

showing the most promise for use as high-temperature lubricants and fluids for the Air Force. By critical screening, Monsanto research has determined that perfluorobenzene appears to be a highly heat-stable building block. By screening various types of compounds, this order of heat stability was disclosed: certain compounds with fluorine and carbon only—stability greater than 1000°F.; special aromatics—up to 1000°F.; nitrogen heterocyclics—up to 950°F.; silicon compounds—to 900°F.; phosphorus compounds—to 850°F. Several major fields of fluorine chemistry have been "blocked out" and the research begun for heat-stable fluids and lubricants.

**CONTROLLED-PERMEABILITY FILMS . . .**

research for the Office of Saline Water on plastic sheeting that can rapidly pass water but retain the ions of dissolved salts. These films would have a controlled permeability based upon their molecular structure—in effect, hold promise for separating a variety of salts from solution and specifically for purifying sea water.

**INORGANIC POLYMERS . . .**

for the Air Force—investigating the bond strength of linkages between various combinations of nonmetals to find "plastics" composed of molecules with phosphorus-to-carbon-to-sulfur bonds; macromolecules with ionic bonding; nitrilic chlorides; cyano-fluorocarbons; and several types of metal-phosphorus-carbon linear polymers.

**HEAT-RESISTANT ADHESIVES . . .**

for the Air Force—polymers to develop high bond strengths between dissimilar materials at elevated temperatures. One series of polymers may yield metal-to-metal bonding that holds firm at 500-700°F., might be used to glue ovens together —and in many plants to eliminate welding.

**HIGH-TEMPERATURE LAMINATING RESINS . . .**

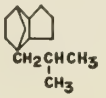
for the Air Force—studies proceeding with a new series of resins that apply as easily as water to blotting paper, that catalytically cure at room temperature, and withstand exposure to temperatures of 500-700°F.

### HYDROCARBON FUEL SYNTHESIS AND EVALUATION . . .

screening compounds for improved jet fuels. Under Air Force contract, some exotic and highly interesting fuel candidates have been prepared, including compounds with spirane linking, steric crowding, and cyclopropyl groupings. Some unusual candidate compounds never before prepared include:



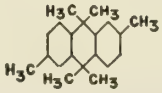
**5,5-dimethyl-4,6-methanospiro [2.5] octane**



**1-isobutyltricyclo [5.2.1.$0^{2,6}$] decane**



**dispiro [5.0.5.1] tridecane**



**2,2,5,9,9,12-hexamethyltricyclo-[8.4.0.$0^{3,8}$] tetradecane**

### HIGH-TEMPERATURE LUBRICANT ADDITIVES . . .

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*For further details on Monsanto's capabilities in the field of special materials development, request a copy of bulletin RE-1: PEOPLE AND PROJECTS.*

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, Number 14 April 3, 1961

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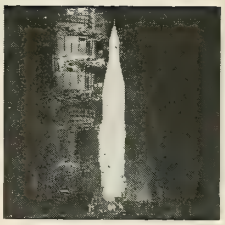
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## THE COVER

*Night fueling of Juno II test vehicle with S-15 atop upper stages prior to a recent static test. The gamma ray satellite will be launched soon. See story on p. 19.*

## APRIL 3 HEADLINES

JFK Asks Polaris Build-up, Shuns DOD Space Plans..... 13
NASA Budget Hike Aimed at Speeding Big Boosters..... 14
Breakthrough: Beryllium Proven Inherently Ductile..... 15
S-45 Satellite Will Be Tracked Around Globe..... 16
S-15 Ready to Hunt for Gamma Ray Radiation..... 19
NASA Puts New Reactor to Work at Plum Brook..... 24
DOD Studies Possibility of Merging TAC, STRAC..... 36
France Earmarks $2.6 Million for Space Program..... 36
Mercury Redstone Proves It's Ready for Man..... 42

## ADVANCED MATERIALS†

Air Force Pushes Research on Vehicle Windows..... 22

## ELECTRONICS

Automatic Abort System Built into Mercury Atlas..... 26
Hughes Designs Data Display for Spacecroft Pilots..... 28

## SPACE MAPPING

U. S. Maps Lunar Surface as Prelude to Exploring..... 34

## ENGINEERING

Survey Shows Salaries Are Continuing to Climb..... 38

## PROPULSION ENGINEERING*

Assembled F-1 Engine Will Get First Tests Soon..... 40

## DEPARTMENTS

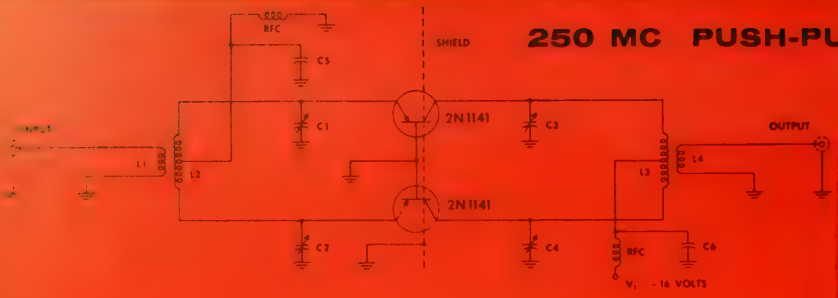
Publisher's Memo ..... 7
The Countdown..... 9
The Missile/Space Week† ..... 10
Technical Countdown ..... 21
Industry ..... 43
Contracts ..... 44
Reviews ..... 44
Products & Processes..... 46
Names in the News..... 48
Letters ..... 48
When and Where..... 49
Editorial ..... 50

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# HOW TO GET 380 mw at 250 m

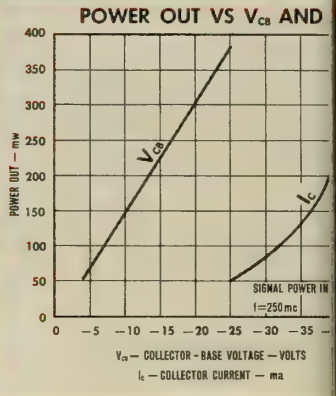
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C5, C6 – 1000 pf Sprague T. V. Bypass Cap.
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L4 – 2 turns No. 18 tinned copper wire; 9/16" diam; 1/4" length

Power in – 30 mw
Power out – 380 mw
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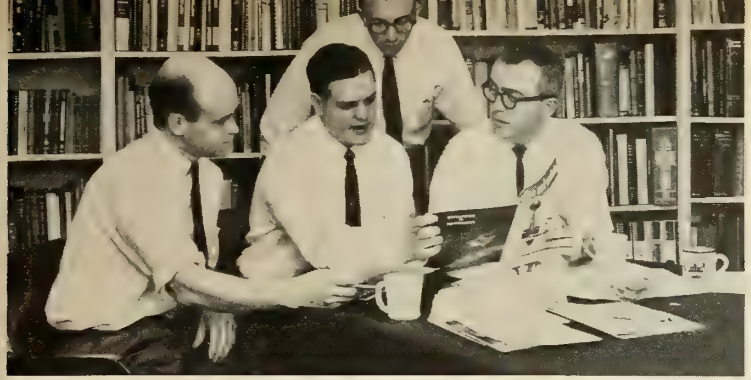
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*JUDD & DETWEILER's Assistant Production Manager Wayne Warner (center) discusses copy deadlines with M/R News Editor Reed Bundy (left), Copy Editor Dave Newman (standing) and Managing Editor Bill Howard (right).*

# memo from the publisher

THE FIRST 165 ISSUES of MISSILES AND ROCKETS, beginning in October, 1956, and continuing through last week, were printed by The Telegraph Press in Harrisburg, Pennsylvania. Owned and operated by retired Army generals A. H. and E. J. Stackpole, Telegraph Press has for many years been a very successful book and magazine printing establishment, and has been producing most of the American Aviation Publications since our company was founded in 1938.

With this issue, however, M/R has a new printer: The Judd & Detweiler Company here in Washington, D.C. The gentleman surrounded in the photograph above by several of our more serious-faced editors is Wayne Warner, Assistant Production Manager at Judd & Detweiler, who will be supervising the printing of M/R each week from now on.

Judd & Detweiler achieved national recognition as printers for many years of National Geographic Magazine. They recently attracted our attention by purchasing several new high-speed color presses, and after we had entered into negotiations with them, told us of additional higher-speed rotary press equipment which they will acquire later this year.

Previously hampered by the distance of 125 miles between our offices here in the Nation's Capital and Telegraph Press in Harrisburg, our editors are now enjoying greater flexibility of deadlines, exploiting the 10-minute liaison with the Judd & Detweiler plant, located just a few short blocks away. And since M/R's editorial offices are located within a few blocks of the Pentagon, the White House and Capitol Hill, our "delivery system" of missile/space industry news will be the most efficient by far of any magazine covering the market.

In fact, many East Coast subscribers will be reading the latest missile/space industry news on Friday, just a day after we go to press. Currently under study is a new delivery plan for Midwest and West Coast subscribers which would provide similar high-speed service.

In the future, look for improvements in M/R from a graphic arts standpoint. Illustrations should reproduce with greater detail and contrast. There will be more use of editorial color, more imaginative layouts. After all, just because you read M/R as part of your job doesn't mean we can't make your required reading visually attractive as well as informative.

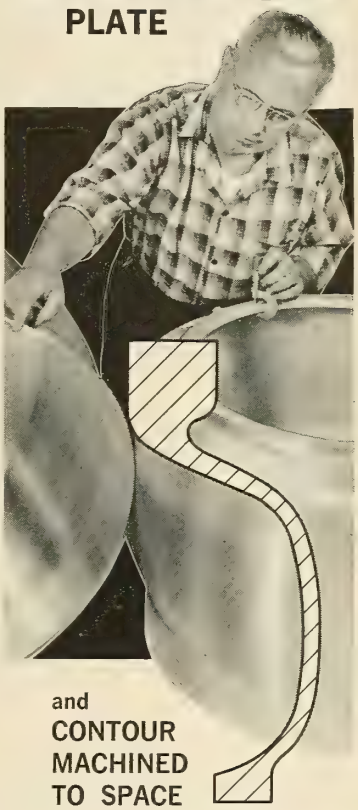
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THERE'S USUALLY a story behind every story, and the feature on page 15 is no exception. M/R Propulsion Editor Frank McGuire attended a Los Angeles meeting of the American Society of Metallurgical Engineers last week, and heard N. E. Promisel, Chief Materials Engineer of the Navy's BuWeaps R&D section, deliver a talk on "New Frontiers in Metallurgy." During his address, Promisel made a passing reference to a new process for establishing the inherent ductility of beryllium which set his audience, including McGuire, to squirming in their seats.

Promisel boarded a plane for Washington before he could be cornered for an interview. However, in a fine display of oneupsmanship, Editor McGuire flagged Managing Editor Bill Howard here in our home office, and Bill in turn had Materials Editor John Judge perched on BuWeapsman Promisel's doorstep by the time he reached home base. Result: a fine, exclusive article on a really important materials breakthrough. And proof of the importance of editorial teamwork in covering the fast-moving missile/space industry.

Edward Muhefeld


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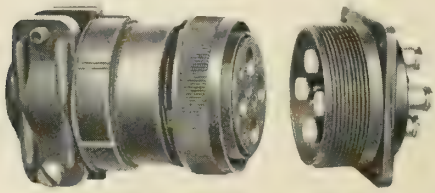
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# The Countdown

## WASHINGTON

### The Man in Charge Speaks

President Kennedy's FY '62 defense budget revisions (see page 13) contain some basic policy statements aimed right at the Pentagon E Ring. Sample: "The basic problems facing the world today are not susceptible to a military solution. Neither our strategy nor our psychology as a nation—and certainly not our economy—must become dependent upon the permanent maintenance of a large military establishment."

### Atlas Tempo Increases

SAC apparently is speeding up *Atlas* deployment operations. For the first time in a month, Rocketdyne last weekend made pre-delivery checkout runs on boosters late Saturday and Sunday night. Several *Atlas* squadrons are nearing the operational stage.

### Water Launch for Saturn?

COUNTDOWN hears NASA-Huntsville is receiving proposals from about 10 companies April 3 on a feasibility study for launching the 1.3-million-lb.-thrust *Saturn* and other heavy space vehicles from offshore facilities—such as ships or Texas towers.

### Titan II Squadrons Cut

Chopping of two *Titan II* squadrons in the Kennedy FY '62 budget revision is expected to affect the ones planned for Griffis AFB, N.Y. The reduction means there will be six instead of eight *Titan II* squadrons in all.

### Secrecy Lid Grows Tighter

Top DOD officials are clamping a tighter security lid on all advanced weapon systems—starting with *Minuteman*. They indicate that details as to size of programs, funding, etc., will be withheld from the public. Total missile procurement for *Minuteman* beyond the 600 disclosed in the FY '62 budget revision for actual deployment is being kept secret. The ban is expected to spread to tactical missiles going into the production stage.

### The Bite of Criticism

Insiders are saying Dr. Clark Randt quit April 1 as NASA's life sciences director because he was unhappy over congressional criticism—notably that of Rep. Emilio Q. Daddario (D-Conn.)

### Bid for More Solid Money

Expect the House Space Committee to add-on some more money for NASA's solid rocket booster program—but nowhere near the $30 million asked by two committee members. Kennedy's FY '62 budget revision eliminated extra money for solids requested by NASA and there's a question whether the House Appropriations Committee will go against his recommendation.

## INDUSTRY

### Missile Cutbacks Hurt

COUNTDOWN hears the Kennedy Administration's decision against going into production of the railroad launcher for *Minuteman* really caught American Machine & Foundry and ACF Industries, the two principal contractors, by surprise. Both were tooled up and waiting for the order to go. It will probably mean some layoffs. Cancellation of the *Eagle* is being felt by Bendix Corp. and its team of contractors, with more layoffs expected.

### Tough New Plastic

Researchers at the University of Arizona have come up with a new plastic—polybenzimidazole—stronger and lighter than steel and able to withstand 1200°F. The pure organic fiber reportedly can be cast only after being put into solution.

### Electrostatic Gyro Contract

General Electric LMED is developing a new gyroscope with an electrostatic suspension rotor for Jet Propulsion Laboratory under a $195,000 contract. The instrument is expected to provide the extremely high accuracies and long maintenance-free life required for future spacecraft navigation systems.

### R&D Intelligence

New Mark 46 tropedo is using a glass-reinforced body, indicative of the trend toward composite materials in "hydrospace" applications. . . . Space Technology Laboratories is under contract to the AFSC to modify *Atlas* and *Titan* boosters to be used as targets for *Nike-Zeus* next year.

## INTERNATIONAL

### New French Arms Czar

All of the armaments work in the French Defense establishment is being put under one man—General Lavoud. He will supervise all research, development and production for the Air Force, Navy and Army.

### Belgium Ready for Space Club

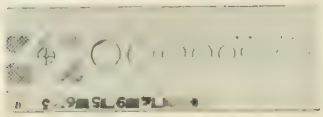
Belgian officials are prepared to contribute $1.1 million annually for five years to participate in the proposed European Space Research program using the *Blue Streak* and *Veronique*—if other countries cooperate. One proviso by the Belgians is that half of their contribution be spent in Belgium.

### Overseas Pipeline

SNECMA of France is submitting proposals to build rocket engines in a cooperative European project. . . . Hector the Space Rat, who traveled more than 100 miles in the nose of a *Veronique* Feb. 22, has sired four little rats. . . . There's a rumor around that Russia already has conducted a successful ballistic rocket shot with a man, and will announce it as sort of an after-thought when it successfully brings a man back from orbit.

# NARROW-CHANNEL PHOTOGRAPHY

For people with the problem of photographing the interior of long, narrow channels, Kollmorgen has developed unusual devices capable of recording on film channels as narrow as 1/32 of an inch.



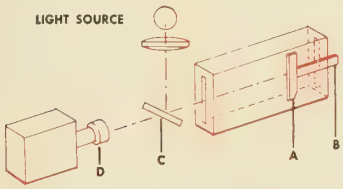
Above, actual size, is a test film of circles and numerals placed within a 1/32"-wide channel.



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# The Missile/Space Week

## Air Force Realigns

*Air Research and Development Command (ARDC) and the Air Materiel Command (AMC) officially bowed out April 1.*

*ARDC has been replaced by the Air Force Systems Command (AFSC) with its research operations being taken over by the Air Force Research Command (AFRC). The Air Force Logistics Command replaces AMC. AMC centers which provided logistics support for ARDC divisions will mostly be reassigned to Systems Command.*

*AFSC, AFRC and AFLC will all report directly to the Air Force Chief of Staff.*

## Private Satellites Delayed

The Kennedy administration last week reversed the former administration's policy of encouraging private industry to launch communication satellites.

In a space message to Congress, President Kennedy requested deletion of an expected income item of $10 million from the National Aeronautics and Space Administration budget for charges to private industry for satellite launching.

It was understood that the new administration has decided to wait at least a year before deciding what role private industry will play in the operation of communication satellites.

Meanwhile, NASA announced that the British General Post Office has agreed to provide ground stations for transmitting multi-channel telephone, telegraph signals by way of satellites to be launched in 1962 and 1963 under Projects *Relay* and *Rebound*.

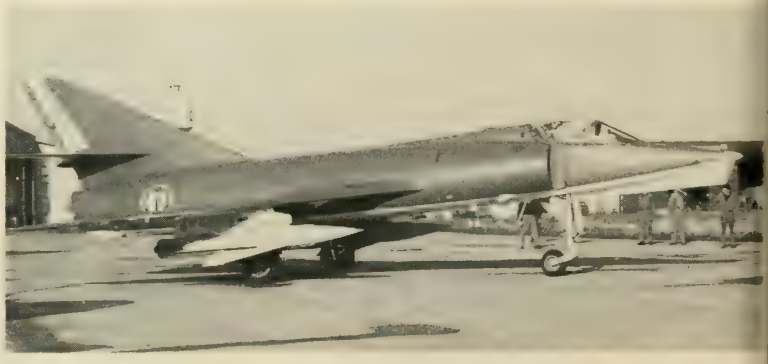
Surveys are under way to determine locations for stations, which will be equipped with advanced tracking and antenna-pointing facilities. The U.S. and Britain indicated they will welcome cooperation by other nations who wish to set up similar facilities.

## Single-Managed Electronics?

Recommendation that management of electronic components and repair parts be placed under the single-manager program is currently being studied by DOD. This proposal, urged by the Armed Forces Supply Support Center as a result of a one-year study, is the principal item in the seven-volume Electrical/Electronic Management Report.

The report calls for setting up a jointly staffed Defense Electrical/Electronic Management Center responsible to the Secretary of Defense. The Center would control inventory and procurement of some 650,000 component items with a value of $1 billion. Such a program would be the largest yet considered by the armed forces.

Other recommendations of the as yet unreleased report have to do, primarily, with standardization and inter-



**Nord's Ground-to-Air AS 30**

*NORD-AVIATION'S new AS 30 missile attached to wings of Dassault "Etendard IV" naval strike fighter. The French missile may become rival of Martin's Bullpup.*

service coordination of procurement and management.

## Shots of the Week:

An improved, 98-foot *Titan* operational prototype flew 5000 miles down the AMR from Cape Canaveral in the third success of the last four launchings. The Air Force missile goes operational this summer.

Also at Canaveral: A *Mace-B* lost power a few seconds after launch and exploded on an isolated tip of the Cape. On March 24, a streamlined *Atlas E* toppled into the ocean about halfway through its full-range test. No mechanical failure was responsible.

Off Canaveral: Nuclear submarine Theodore Roosevelt attempted to launch its first *Polaris* missile while submerged, but the bird suddenly veered out of control and had to be destroyed.

## Explorer X Findings

There's much more magnetism in interplanetary space than anyone suspected.

*Explorer X,* America's optical-pumping magnetometer satellite, has found fields well in excess of two gammas in the region beyond 60,000 miles — an altitude considered by space scientists to be the beginning of interplanetary space.

The 2-gamma finding, recorded by a crude magnetometer aboard *Pioneer V* last year, had been subject to some skepticism on the part of scientists at the National Aeronautics and Space Administration. However, the higher readings by the more sophisticated magnetometer on *P-14*—designated *Explorer X* when it went into orbit—tend to confirm the *Pioneer V* data.

The magnetic data will require a reworking of current ideas of how clouds of protons and other particles travel outward from the sun, both during quiet periods and in solar flares.

*Explorer X,* which reached apogee of 112,500 statute miles at 3:40 a.m. (EST) March 27—43½ hours after launching from Cape Canaveral—recorded data during a period of relative solar quiet. Thus the increased readings cannot be ascribed to unusual solar activity.

Dr. James P. Heppner, project director at Goddard Space Flight Center, declined to release any of the preliminary readings from the Blossom Point, Md., tracking station until they are confirmed by information from other stations. Tape recordings from these are expected in a few days.

Heppner and other NASA scientists said they consider *Explorer X* a success and are very pleased with the information received. The *Delta* booster launched the spacecraft for its third straight success, reaching an apogee 12,500 miles higher than required. The batteries provided full power for 60½ hours, 5½ more than necessary.

Transmission from the 78-lb. spacecraft continued at full power for 17 hours past apogee, and weak signals for another 3½ hours. Trackers estimated it would reach a perigee of 110 miles over the Western Pacific at 10 p.m. (EST) March 28. However, there was no assurance of any optical sightings to confirm the orbit.

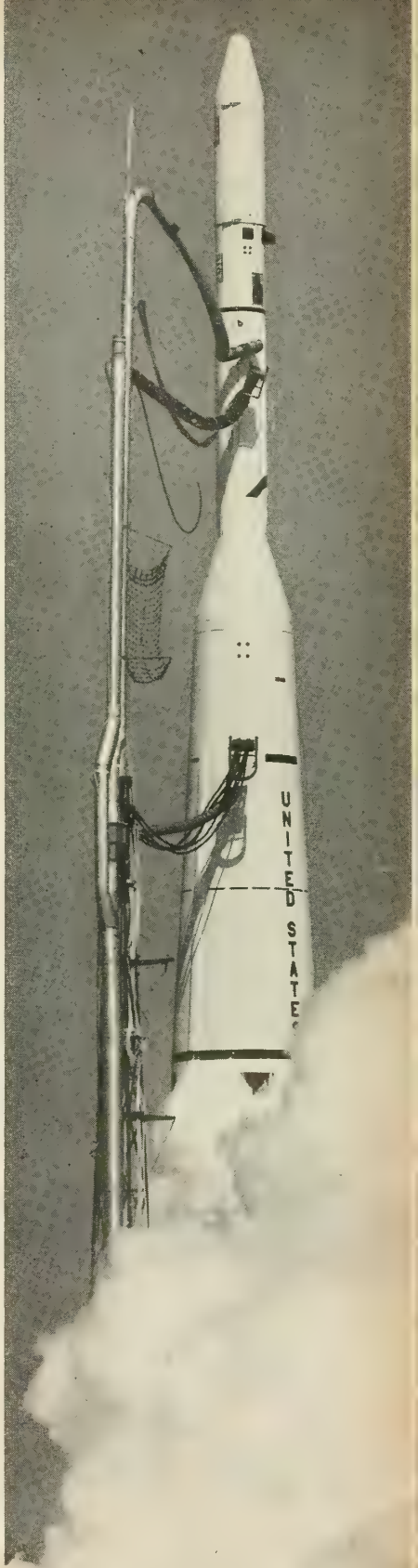
*Explorer X's* orbit carried it away from the sun and in the general direction of the moon. However, it was about 30° away from a trajectory toward the moon. The next launching of a similar magnetometer will be aboard *Ranger I,* a prototype moon-landing capsule to be sent on an interplanetary trajectory this summer.

## AF Asks NORAD Proposals

The Air Force is asking industry for proposals on a development-production contract for an automated NORAD Combat Operations Center. It says proposals are due at Hanscom Field by April 19.

Companies—or teams—desiring the request for proposal must advise the 425L System Program Office (SPO), L. G. Hanscom Field, Bedford, Mass., in writing of their intention no later than April 12. Requests must include team organization (if contemplated), current facility security status of prime or team leader, and statement of experience and qualifications. Verification of current or previously assigned security status by cognizant DOD security agency must also accompany the response.

The 425L system will provide NORAD with a hardened control center for defense of continental U.S. Canada and Alaska against aerospace attack. It will be located six miles south of Colorado Springs.




*HIGHLY SUCCESSFUL launch of Explorer X from the Cape on March 25.*



# "EUREKA" IS HARDLY THE WORD FOR IT, ARCHIMEDES!

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# Bold Space Steps Deferred

# Kennedy Stresses Step-up of Polaris

by William E. Howard

**Revised FY '62 defense budget also aims to add limited war capability; Ike pattern followed**

BIG AND BOLD plans to give the United States a strong military position in space are being shunned by the Kennedy Administration—at least for the present.

Instead, the new commander-in-chief is asking Congress to beef up the ICBM program—chiefly through the addition of 10 *Polaris* submarines—and to expand the nation's limited war capability in non-nuclear armaments.

Sharp revisions were made in the FY '62 Eisenhower Defense Budget in some programs. But the revised budget sent to Capitol Hill last week by President Kennedy generally followed the pattern set by Eisenhower.

The new emphasis is on "insuring" the nation's ability to retaliate in a big war. But it falls short of Air Force arguments for a vast "counterforce" capable of prevailing in any type of war.

Kennedy is requesting an increase of $1.954 billion in new obligational authority, but asked for only an additional $650 million in FY '62 spending. Kennedy said underestimates in spending made by Eisenhower would boost the total spending add-on to $890 million.

Thus the new total for new obligational authority would be $43.794 billion and the new spending figure, $43.8 billion.

• **Missile specifics**—This is what the new budget would do to missile programs:

—Provide $1.340 billion to accelerate *Polaris* submarine production to one-a-month beginning in mid-1963. The additional subs would raise the total authorized to 29, including the five added in January to the FY '61 program. Funds are also recommended to speed up development of the 2500-mile A-3 *Polaris*, train 2500 new crewmen and buy extra missiles for training shots.

—Earmark $96 million to substitute three fixed-base (150 missiles) *Minuteman* squadrons for three train-based squadrons (90 missiles). The money also would be used to double production facilities in existing contractor plants, improve the missile and provide extra ones for training shots. The mobile *Minuteman* program will remain in R&D.

—Double *Skybolt* R&D by the addition of $50 million.

—Cancel the last two *Titan II* squadrons (18 missiles) at an immediate saving of $100 million and an overall saving of $270 million.

—Kill the Navy's *Eagle* air-to-air missile at a saving of $57.7 million.

—Phase out the *Snark* at a saving of $6.9 million.

—Cancel installation of *Polaris* on the cruiser Long Beach at a saving of $57.7 million.

Under the revision the Big Four missile programs would give the nation a total of 1301 ICBM's by 1965. The individual totals: *Atlas* — 129 (no change); *Titan*—108 (reduced by 18); *Minuteman*—600 (net increase of 60); *Polaris*—464 (net increase of 160).

Kennedy refused to commit the Army's *Nike-Zeus* antimissile missile to production. Defense officials said flatly that *Zeus* R&D had not advanced to the point where it could be committed to production. This means that Kennedy is following the Eisenhower recommendation to wait until the *Zeus* is tested against ICBM's next year, with the result that if it proves out, the earliest *Zeus* can be deployed is mid-1965.

• **B-70, ANP**—The President's defense plan found general approval in Congress—with the exception of his decision to cut back the B-70 Mach 3 bomber by $138 million and reduce the number of prototypes proposed by Eisenhower from 12 to 4. The new program would permit only the development of the B-70's airframe, engines and bomb-nav systems.

Defense officials indicated the cutback stemmed from a decision that the B-70 does not contribute anything unique to the deterrent force over and above ICBM's and the B-52 bomber fleet.

Also getting the hatchet was the aircraft nuclear propulsion program upon which $1 billion already has been spent. The reduction of ANP to minor R&D had been anticipated (M/R, March 6, p. 9).

Much stress was placed upon better warning systems and enhancing the survivability of SAC's jet bombers. Kennedy requested $44.6 million to place 50% of the 1600 bombers on 15-minute ground alert instead of the present one-third. There was no more money for air alert, however, and no indication that the President would authorize the stockpiling of air alert items.

• **Limited war increase**—NOA for limited war armaments topped $765 million and covered such items as: $129 million for 13,000 more men in the Army, Navy, AF, and Marine Corps; $345 million for a new amphibious transport and other Navy seaborne procurement; $45 million for a joint Air Force-Navy advanced tactical fighter to substitute for the cancelled Missileer; $122 million for more research on development of non-nuclear weapons and $25 million to improve the F-105.

The potential Soviet threat in space was ignored in the President's message. He said only that there were "a number of other space and research programs related to our strategic and continental air defense forces which I find require additional support." The ones enumerated to receive $226 million in new obligational authority were: *Dyna-Soar, Discoverer, Advent, Defender,* missile defense and penetration aids (electronic countermeasures) and "certain other programs" which were not revealed. *Midas,* the infrared missile early warning satellite, was singled out for a $60 million "acceleration" increase.

How much of the $226 million would go to *Dyna-Soar,* the Air Force's orbital space bomber, was not reported in the message. But it was believed to be less than the $100 million requested to accelerate the program by 19 months and provide for the first manned flight by mid-1963.

Taken as a whole, Kennedy's proposals dealt at least a temporary blow to the Air Force in its newly won role as the military space agency. With no money sought for big new booster programs with which to mount a major

manned space exploration effort, the Air Force will be continuing in the satellite-launching role prescribed by Eisenhower.

There were other meaningful hints that Kennedy himself was taking a "second look" at the whole idea of manned space exploration. NASA officials said that their man-in-space program hinged entirely on the success of *Mercury*. Plans to go into hardware on the follow-on *Apollo* spacecraft are being postponed at least until after the first manned *Mercury Redstone* ballistic shot this spring.

President Eisenhower in his parting budget message recommended that the whole man-in-space program be reviewed after *Mercury* to determine whether it was worthwhile to proceed further into space.

Military planners, on the other hand, have insisted that the Soviets are employing their "peaceful" space program to develop strategic systems. These planners contend that the U.S. should move rapidly into space on the theory that whoever controls space also would control the earth.

• **Mobility fight settled** — If Congress goes along with Kennedy's recommendation on *Minuteman*, the Navy's *Polaris* will be the sole long-range, mobile big missile until *Skybolt* comes along. The decision to scratch plans for putting *Minuteman* on trains by 1963 was made both for economy and technical reasons. It is understood that DOD felt the problems associated with jouncing the guidance package over the railroads were far from solved.

Although *Polaris* will not go aboard the Long Beach, DOD did not rule out the possibility of deploying it aboard other surface craft.

The *Polaris* acceleration will mean that the Navy must complete the development of the 1500-mile A-2 model by the spring of next year and have the 2500-mile A-3 ready in the summer of 1963—two years ahead of schedule. This could prove to be one of the roughest hurdles yet encountered by contractors in the program. ⌗

# NASA Increase Will Hurry Big Boosters

A MAJOR EFFORT to speed existing big booster programs—and a further deferment of decision on manned space flight beyond Project *Mercury*—are reflected in President Kennedy's request for a $125.67 million addition to the civilian space agency budget.

In a vain effort to balance the civilian portion of his revision of former President Eisenhower's budget, Kennedy sliced $195 million from the $320 million in new obligational authority sought by Space Administrator James E. Webb.

Addition of $16.1 million to the Atomic Energy Commission's budget for space research brought the total increases in the civilian space program to $142.1 million.

Kennedy modified the space program after a series of meetings with Webb, Vice President Lyndon B. Johnson, Presidential Science Adviser Jerome Wiesner, Budget Director David Bell, Deputy NASA Administrator Hugh Dryden and Space Council Director Edward C. Welsh.

• **Place for Apollo**—Although no additional funds were sought for Project *Apollo*, high officials said the new administration has no plan to scrap the project in favor of the Air Force's *Dyna-Soar*. Dryden declared he is convinced there is a place for both *Apollo* and *Dyna-Soar* in the nation's man-in-space plans.

Dryden said the technical staff feels it would be "a little happier if we had *Mercury* under our belt" before making a major decision to go ahead with *Apollo*. Meanwhile, he said, the $29 million of industry research and development provided in the original Eisenhower budget will go for high-speed re-entry tests with *Atlas-Agena B* and *Saturn* launches, further life sciences studies with the *Mercury* capsule, early work on the *Apollo* escape system, mission analysis and research in heating of materials and structures, radiation effects and flight support.

## Space Budget at a Glance
## Fiscal Year 1962

| | Eisenhower Budget | Kennedy Budget |
|---|---|---|
| | *(in millions of dollars)* | |
| New obligational authority | 1,119.6 | 1,235.3 |
| Estimated spending | 965 | 1,050 |

## Major Kennedy Increases

| | |
|---|---|
| SATURN C-2 | $78 |
| CENTAUR | $25.6 |
| ROVER | $14.1* |
| F-1 | $ 9 |

* *Includes increases in AEC budget*

Kennedy also deleted an item of $8 million for solid propulsion studies and something more than $2 million for electrical propulsion. Dryden said both NASA and the Department of Defense are working on solids and both must agree before a new booster development begins. The NASA official said he believes the next step in solids should be a booster about the size of a *Thor* or an *Atas*.

• **Additions**—The largest item in the Kennedy add-on was $78 million to begin development of the *Saturn C-2*. The decision will make it possible to fly the seventh vehicle in 1966 instead of 1967. The shortened development time will make it possible to fly men around the moon in 1968 instead of 1969.

The *Saturn C-2* additions break down to $56 million for developing a new 800,000-lb.-thrust second stage, $11 million to complete work on *Saturn* launch Complex 37 at Cape Canaveral, $4 million for a second static test stand at Huntsville, Ala., and $7 million for additional NASA personnel and plant.

The *Centaur* program, which has run into trouble in the last few months, will get $26.6 million in an all-out drive to make up lost time or, if that proves impossible, at least to prevent further slippage.

The *F-1* single-chamber 1½-million-lb.-thrust liquid engine receives $9 million additional to enable it to meet its schedule of flight rating by 1965.

The *Rover* nuclear rocket program receives $14.1 million to speed reactor and component development — $4.1 million in the NASA budget and $10 million in that of the Atomic Energy Commission. In addition, the AEC receives $6.5 million to speed work on *SNAP* nuclear space power systems.

The budget increase will allow NASA to hire 780 additional employes —460 at Huntsville, 70 at Goddard Space Flight Center, and smaller groups elsewhere—including 180 at aeronautical research centers to work with the Federal Aviation Agency on developing a supersonic transport plane.

• **Cuts and switches**—Two items were cut: $1.05 million from ground instrumentation designed for communication satellites, and $700,000 from plans to build a vivarium to house animals at Ames Research Center.

The budget also showed some juggling of funding between NASA and DOD so that one agency or the other will fund all of a given launch complex at Cape Canaveral. DOD will fund the modification of Complexes 13 and 14 for *Agena* upper stages, while NASA will fund *Centaur* Complete 36B. ⌗

*Major breakthrough . . .*

# Navy Finds Beryllium To be Inherently Ductile




*ZONE-REFINED single crystal of beryllium bent at room temperature proved to be free of fracture. Basal plane orientation is indicated. The key to ductility was provided by the application of a zone-refining process.*

THE MYSTERY of beryllium's brittle behavior has finally been solved—the metal is inherently ductile.

Previously metallurgists were never sure whether the brittleness stemmed from beryllium itself or from failure to develop optimum metallurgical conditions.

Ductility in single crystals of beryllium is being achieved by researchers at the Franklin Institute, Philadelphia, under a program sponsored by the Bureau of Naval Weapons. (see chart)

Taking the approach that extensive ductility should occur with the removal of trace impurities, a zone refining technique was perfected to purify the beryllium specimens. Details of the process are not yet available.

N. E. Promisel, Chief Materials Engineer, BuWeaps, stressed that the development involved single-crystal beryllium and not the polycrystalline form normally met in structural applications. But he is optimistic about future results.

The crystals were grown so that the basal plane intersected the specimen axis at a 45° angle. Eight passes in the zone refining process resulted in a ductile crystal.

The orientation of the basal plane was required to induce the necessary shear stresses to produce flow in the basal plane. Basal plane cleavage is by far the most prominent and frequent fracture mode in beryllium.

If distortion in shear without fracture could be achieved after refining, then the brittleness of beryllium could be laid to impurities.

• **Oxygen's innocence?** — Project spokesmen say that the exact degree of purity in the refined crystals has not yet been determined. They are positive that all of the oxygen was not eliminated.

Future work at Franklin will define the significant impurities by recontaminating the zone-melted crystals. These studies will also include polycrystalline beryllium.

Apart from the purification route, the Navy has had some degree of success in forming ductile beryllium wire. The key here was the proper orientation of the grain.

Composite processes, involving beryllium in a ductile matrix of silver or aluminum, led to specimens capable of a 75% cold reduction at room temperature. Such specimens suffered in strength but not in modulus or heat capacity.

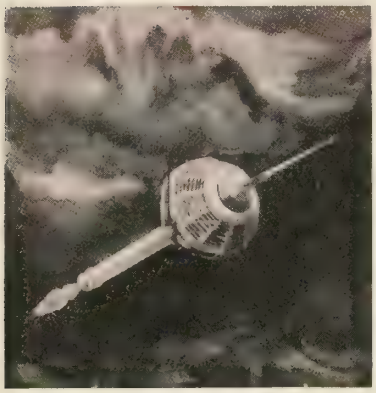
The single-crystal approach has been suggested by various investigators. But the adaptation of zone-refining techniques to beryllium crystals represents an additional step in the usual procedures. The program has been in operation at Franklin Institute for a little over 18 months; most of this time was spent in modifying zone melting methods to fit the task. ⌘

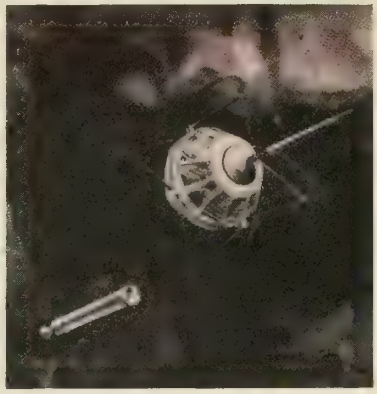
### Tensile Tests of Zone-Refined Beryllium Crystals

| BASAL PLANE ANGLE TO THE LONG AXIS OF THE TEST BAR | NUMBER OF ZONE PASSES | SLIP SYSTEM | REDUCTION IN AREA % | ELONG. IN ½ INCH % | GLIDE STRAIN | SHEAR STRESS BASAL (0001) PSI |
|---|---|---|---|---|---|---|
| 45° | Reference Melted Crystal | Basal | <1 | <1 | | 2500 |
| 45° | 2 | Basal | 8.0 | 8.1 | 18 | 1750 |
| 45° | 8 | Basal | 50.2 | 100 | 160 | 500 |

# S-45 Will be Studied around the Globe

## *Five major scientific groups will cooperate with NASA when second try is made in late spring to launch ionosphere craft*







*ARTIST'S CONCEPTION of the launching sequence of the pay load of the S-45 Ionosphere Beacon Satellite.*

**by Jay Holmes**

THE UNITED STATES is inviting scientists around the world to conduct ionosphere experiments by studying signal reception from the *S-45* ionosphere beacon satellite.

Another attempt will be made in late spring to launch *S-45* with the final *Juno II* vehicle. The first attempt on Feb. 24 was spoiled by an upper-stage failure.

The spacecraft, weighing 75 lbs., consists of a crystal oscillator powered by solar cells and rechargeable batteries designed to transmit on six frequencies continuously for 13 months. Its orbit will be highly elliptical—from 240 to 1600 statute miles—so as to obtain information from various areas of the Van Allen radiation belts.

Experimenters on the ground will be able to draw extensive conclusions on the daily and seasonal variations of the ionosphere—as well as the effect of solar activity—by studying variations in the quality of the signals received. They also will be able to draw conclusions about the effect of the earth's magnetic field on the ionosphere and about time variations in the magnetic field.

During the International Geophysical Year, scientists discovered with rocket flights in the Arctic that solar particles disturb the low-altitude D-layer of the ionosphere. At higher altitudes, the disturbance results from electromagnetic radiation in the ultraviolet and X-ray spectral regions. Profiles of electron density—a standard measurement of ionosphere quality—were obtained in detail up to about 150 miles altitude. However, only a few measurements above that altitude—to about 300 miles—were obtained by Soviet and American rockets and satellites.

The indication from the information available to date is that during the day the D, E, and F ionosphere layers blend together and separate again by night. However, much more data is needed before firm conclusions can be drawn.

• **Broad cooperation**—Five major scientific groups already have arranged to cooperate with the National Aeronautics and Space Administration in observing the transmissions from *S-45* on frequencies of 20.005 mc, 40.010 mc, 41.01025 mc, 108.027 mc, 360.09 mc and 960.240 mc—all harmonically related to the basic oscillator frequency of 1.00025 mc, stable to one part in 10 million for periods of a half-hour.

The frequencies of 20, 40 and 41 mc, radiated by a loop antenna 6 ft. in diameter, will be polarized perpendicular to the axis of spin of the satellite. The other three frequencies, radiated by rod antennas, will be polarized along the spin axis.

The major observations to be made are the Faraday effect and the Doppler effect on the transmissions. The Faraday effect rotates the polarization of a signal as it passes through an ionized region. The amount of rotation depends on the frequency of the signal, the magnetic field strength, the direction of the signal and the density of electrons along the path.

By receiving the signal with two antennas on the ground at right angles the rotation of polarization can be determined. The aspect of the satellite itself is telemetered to the ground separately. Aspect can also be established by comparative measurement of signal amplitudes on the various frequencies.

The Doppler effect varies the frequency received on the ground according to the velocity of the satellite with respect to the ground station. If there are no electrons between the satellite and the station, the frequencies received vary in the same proportion as those transmitted.

However, the presence of electrons in the ionosphere affects the various frequencies differently. By comparing effects on the different frequencies, by a process called differential Doppler, scientists can compute the electron density. Such a process requires making certain assumptions, however. To avoid the necessity for making assumptions, one experimenter is measuring the differential Doppler at two stations separated by more than 100 miles, NASA said.

• **Experiments**—The five principal investigators are Dr. W. J. Ross of Pennsylvania State University, R. S. Laurence of the National Bureau of Standards, F. de Mendonca of Stanford University, Dr. G. W. Swenson of the University of Illinois, and Dr. J. E. Titheridge of the University of Auckland, New Zealand.

The Penn State experiment calls for receiving *S-45* signals at University Park, Pa., and Huancayo, Peru, and comparing them with similar signals from *Sputnik III*, the U.S. Navy's

*Transit* satellites and future Soviet *Sputniks*. Penn State will pay particular attention to signals received at night and to low-altitude passes. In conjunction with the 23 months of records from *Sputnik III*, Penn State will seek to evaluate the effect of the solar cycle on the total ionosphere. Doppler effect methods will be used.

Ross also plans to study the phenomenon of phase scintillation of satellite signals, so as to determine the structure, location and occurrence of irregularities in the ionosphere.

The National Bureau of Standards, at its Central Radio Propagation Laboratory in Boulder, Colo., plans to use the Faraday effect to study daily and seasonal variations. By measuring the amplitude and angle of signal arrival, NBS plans to plot irregularities.

NBS plans to compare its results with 20 mc signals from the new satellite with similar results it attained with 20 mc signals from *Sputnik III*. An ambiguity in the method of analysis prevented establishment of the total electron content of the ionosphere from *Sputnik III* data. However, NBS plans to remove the ambiguity by comparison with *S-45* results on 40 and 41 mc.

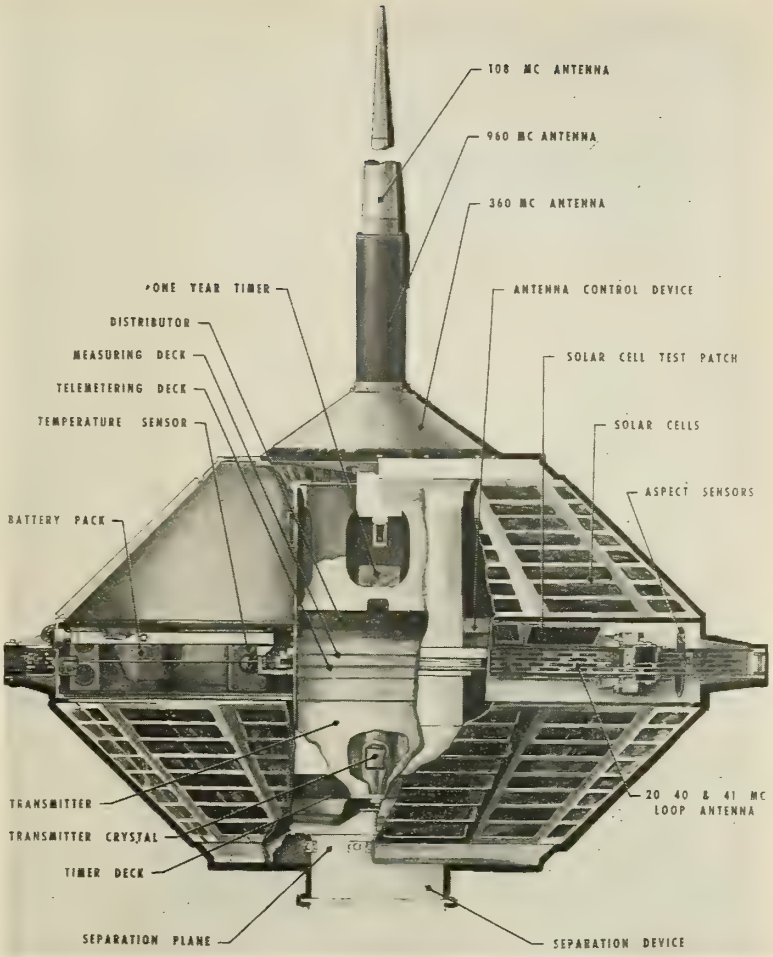
The Stanford University Electronics Laboratory will make observations at the university and at the University of Hawaii. Both Faraday and Doppler methods will be used to study the effects of solar and magnetic storms on the electron content of the ionosphere and of the size and times of occurrence of ionospheric irregularities.

Stanford also will study long-range radio propagation, including reception at the antipodal point—on the other side of the earth from the point of transmission—as well as multi-hop and tilt-mode propagation from the satellite.

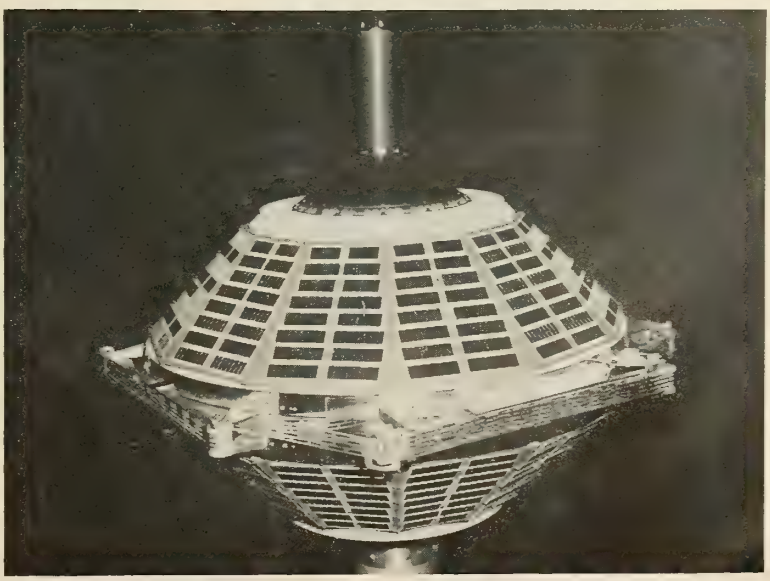
The University of Illinois will concentrate on scintillations in signals from the satellite, caused by an ionosphere region above 145 miles altitude and north of the 40th parallel. Measurements will also be made with receivers spaced some distance apart. A third area of study will be the determination of total electron content of the ionosphere from Faraday rotation.

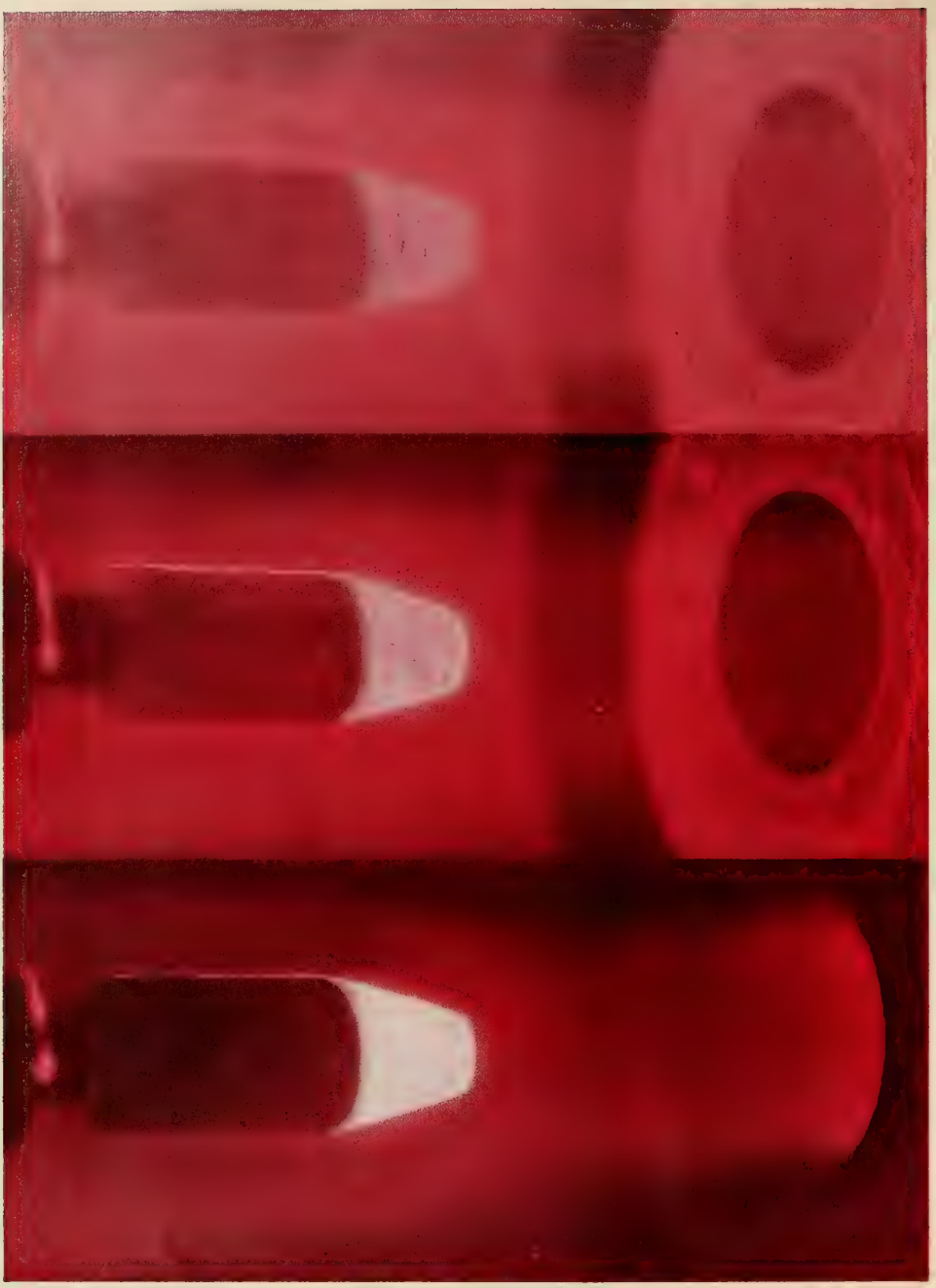
The Seagrove Radio Research Station of the University of Auckland will concentrate on the bearing and elevation angle of antipodal signals from the satellite. A radio frequency interferometer to be used will have one fixed axis and—in an unusual technique—one axis that rotates in the horizontal plane.

New Zealand has a particular interest in antipodal signals because a great part of the country's communication with the rest of the world depends on antipodal radio reception. ⌘




**ABOVE:** *Major parts of the S-45 Ionosphere Beacon Satellite shown in cutaway. Solar cells and rechargeable batteries power crystal oscillator capable of transmitting on six frequencies continuously for 13 months. Three frequencies are polarized perpendicular to axis of spin, three along axis.* **BELOW:** *Exterior view.*





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# S-15 to Hunt for Gamma Radiation

THE GAMMA RAY astronomy telescope satellite—designated *S-15* is expected to be launched soon.

The 82-lb. *S-15*, a box and cylinder combination 44 in. long and with diameter varying between 6 and 12 in., was to be launched by a *Juno II* vehicle from Cape Canaveral into an orbit varying between 300 and 600 statute miles altitude (see report in M/R, Feb. 6, p. 24).

Tumbling end over end at a controlled rate of about 10 rpm, the satellite's telescope is to scan the sky for radiation in the very-short-wavelength gamma ray region—which is absorbed by the atmosphere and thus never reaches the earth. The intensity and nature of gamma radiation from the stars can provide astronomers with a great deal more information about their nature.

The telescope, designed by Massachusetts Institute of Technology for the National Aeronautics and Space Administration, operates on the coincidence principle, since it is impossible to focus the highly penetrating gamma radiation with reflecting surfaces. Two Cerenkov scintillators are placed at opposite ends of the telescope tube and the circuitry is arranged so that only radiation that strikes both scintillators is counted. Thus it measures only radiation entering the telescope along its longitudinal direction.

The source of gamma radiation—which is electromagnetic—can be determined exactly from the direction. This is untrue of particles such as protons and electrons, whose path is curved by magnetic fields in space.

The satellite will remain attached to the 12.8-lb. empty fourth-stage motor casing, which will add an additional 44 in. in length. A section of the transmitting antenna will add length and weight to help achieve the tumbling action.

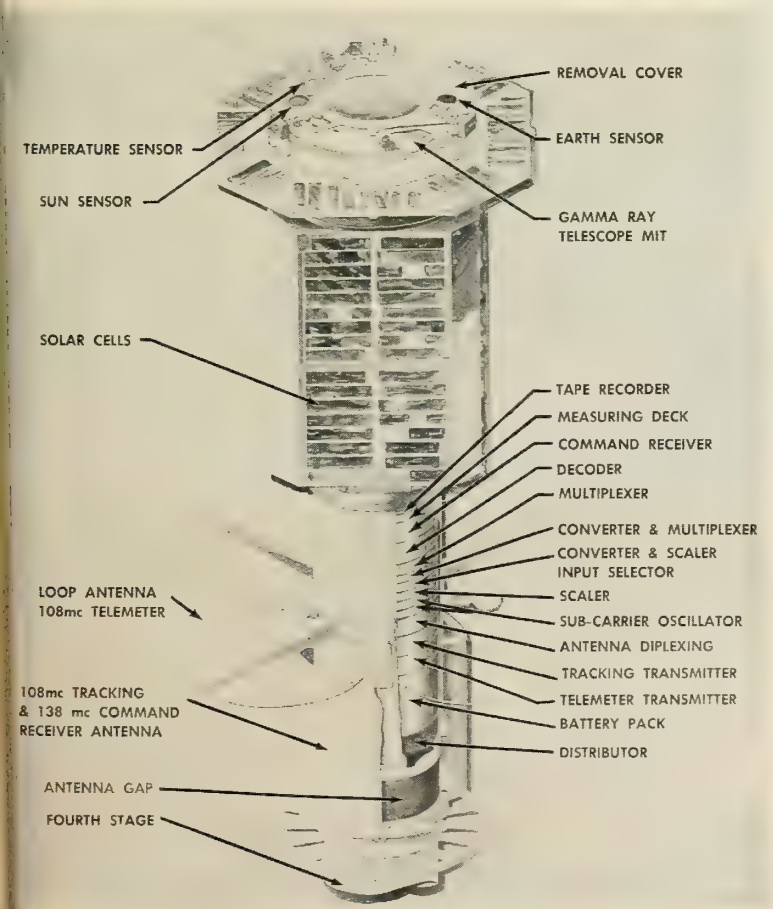
An unusual damping mechanism is built into an adapter at the aft end motor case to control the tumbling. Like all payloads boosted by *Juno II*, the satellite will be spinning at about 380 rpm when injected into orbit. The spin gradually slows in orbit as a result of magnetic and frictional forces but under normal conditions this occurs very slowly and at a rate that cannot be predicted accurately.

The slowing of the spin rate introduces the tumbling by the action of gyroscopic precession. However, the *S-15* motor case adapter has a container of mercury, which expands under the heat of the rocket motor. The expansion moves the heavy mercury outward, increasing the moment of inertia and slowing the rate of spin. As a result, the tumbling begins immediately.

Signals from sun and earth sensors will enable a computer on the ground to compute the satellite's orientation at any given moment and thus the direction of the gamma radiation.

The satellite will carry two transmitters. One will radiate 125 mw on 107.97 mc from four loop antennas around the housing with tape-recorded data on command from ground stations in the Minitrack network. A tracking beacon will operate on 108.06 mc with power of 20-25 mw. Solar cells will recharge the 12 nickel cadmium batteries for an expected life of more than six months.

The selected orbit, at an inclination of 28° to the equator, was chosen so that the telescope will scan the sun during the early part of its lifetime and so that an appreciable fraction of time will be spent below the inner Van Allen belt, so as to minimize radiation damage to the solar cells. ■



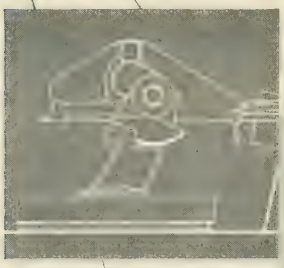

*RTIST'S CONCEPTION of NASA's S-15 gamma ray astronomy telescope satellite.*

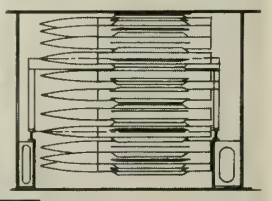


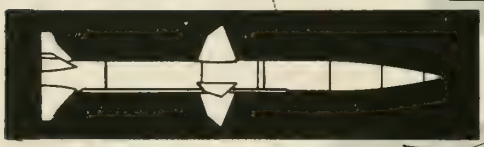
# IT'S THE MAN BEHIND THE SCENE WHO COUNTS

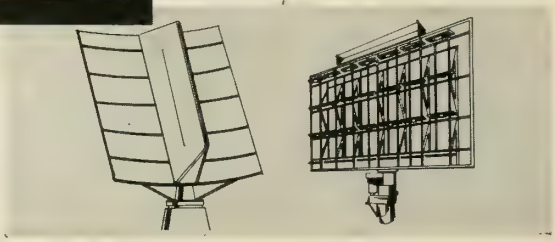
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# Technical Countdown

## ELECTRONICS

### Low-Cost Micro-units Developed

Low cost and high-volume production of microminiaturized modules is reported by Burroughs Corp. with its new BIPCO units. First production model—a binary-to-decimal converter—is about the size of a postage stamp and contains 40 silicon diodes with circuitry and mounting. Units are priced at $45 in small quantities.

### Japanese Electronics Imports Climb

The U.S. imported $94 million worth of Japanese electronic products in 1960—a 24% gain over last year. Biggest items were commercial products—radios, recorders, speakers—but substantial gains were also posted in tubes, transistors, and other components. Electronic Industries Association is taking a hard look at this trend and may fight to limit such imports to protect its member companies.

### New Use for Satellites

A signal from *Tiros II* was used by RCA to trigger an explosive charge to break ground for its new advanced space environment center at Princeton, N.J. The weather satellite was built there by the Astro-Electronics Division, which will occupy the multimillion-dollar facility when completed.

### Cyrogenic Delay Line in Development

Air Force has awarded a $90,000 contract to The Martin Co. for development of a superconducting 20 musec cryogenic delay line operating between 4 and 12 gc. The line is to be encapsulated in a 3-in cube and maintained at a temperature within four degrees of absolute zero.

### Fuel Cells Slated for Orbit Test

Flight testing of fuel cells as auxiliary power sources for satellites is scheduled for the "near future." General Electric MSVD is working on three regenerative hydrox cells for the AFSC (Air Force Systems Command) test program. Units are designed for 50-watt output.

## SUPPORT EQUIPMENT

### World's Fastest Camera?

A new research camera developed by STL has shutter speeds of up to 2.5 nanoseconds. To be used in the study of plasma physics, the ultrahigh-speed camera is shuttered electronically by a special RCA-built image-converter tube.

### Antenna Market Grows

An indication of the size of the radio-radar antenna market is one company's estimate that 35 companies received contracts of $100,000 or more in 1960.

### Research in Fuel Cells Expands

Private research in fuel cells is running to $15 million annually. Anthony Moos, of Leesona Corp., foresees applications ranging from 1000 kw ground power units to automobile engines.

### Measurement Committee Proposed

Work is going forward on the organization of an interociety technical committee for precision measurement and standards. Sponsored by the George Washington University Center for Measurement Science, the proposed group has been okayed by AIEE, IRE, ISA, ASME, ASTM, and representatives of DOD, Bureau of Standards, and other government agencies. Support of IAS and ARS is now being sought.

## ASTRONAUTICS

### Einstein vs. Fitzgerald-Lorentz

Final answer to which theory of the velocity of light—Einstein or Fitzgerald-Lorentz—is correct may come from a series of observations made between 1878 and 1900. Recent analyses of the study showed unexplained variations in the observed timing of eclipses of Jupiter's moons. These variations, some investigators feel, may be caused partly by different light velocities out and back. If so, the fact would support validity of the Fitzgerald-Lorentz contraction theory in opposition to Einstein's relativity theory.

### Rotochute Tests Successful

Kaman's Rotochute re-entry/recovery device has successfully passed transonic wind-tunnel deployment tests at Arnold Engineering Development Center. Still to be solved in the AFSC project is problem of controlling vehicle's descent rate and direction.

## ADVANCED MATERIALS

### Polyurethane for Heat Shield

AFSC is experimenting with a sprayed-on polyurethane coating to protect air-to-surface missiles from thermal radiation. Coating will also be used on aircraft for protection against heat of nuclear blasts and that generated by its own missiles when fired.

### Plastics Fail in Mockup Scheme

Vehicle mockups using all-plastic construction with metal tie-rods have been virtually discarded—after considerable effort to make them a feasible substitute for plaster and other materials. Several firms reportedly found the necessary epoxy resin hard to work with; the resulting fourfold cost over plaster prompted gradual disinterest in the scheme.

### New Material Strongest above 1800° C.

Boron Pyralloy, said to be 70% stronger than pyrolitic graphite, has been developed by High Temperature Materials, Inc. The new substance has a room-temperature bend strength of 37,000 psi, comparing favorably with many aluminum alloys. Thermal properties are such that Pyralloy provides a 4000°F temperature drop over a 1/20 in. thickness. Its use makes it possible to reduce both size and weight.

### Helium-3 Used in Cryostat

Westinghouse scientists are using helium-3 to reach temperatures from 0.3° to 1.0° A in a routine fashion. The rare gas is released in the gradual decay of tritium or hydrogen-3 and in hydrogen fusion. Four liters of helium isotope cost about $500, even after a tenfold price reduction.

## PROPULSION

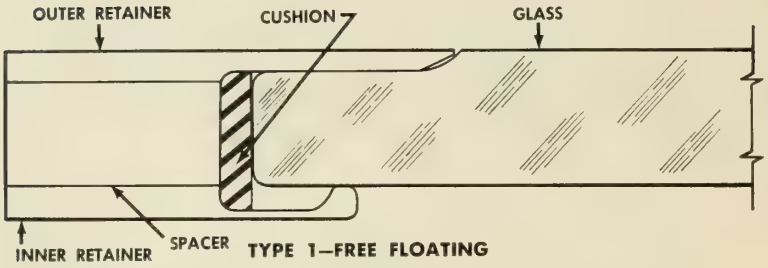
### Titan II on Rush Schedule

Turbopump drive assemblies for *Titan II* engines were moved from drawing board to tested prototype within eight weeks by Western Gear Corp. during an all-out, around-the-clock effort to supply Aerojet with the critical components.

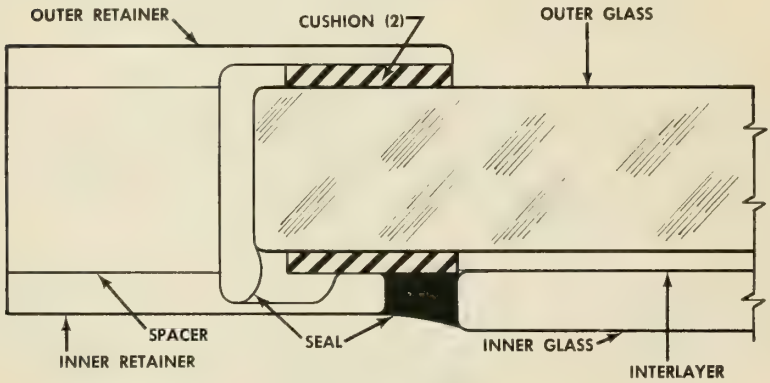
# AF Presses Work on Vehicle Windows

***Corning reports on research with alumino-silicate glass and Narmco study of mounting techniques***

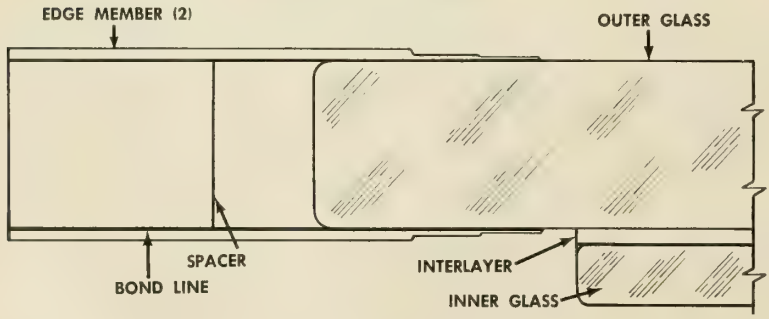
**by John F. Judge**




**TYPE 1—FREE FLOATING**




**TYPE 2—FREE FLOATING**




**TYPE 3—LOAD CARRYING**

*NARMCO'S STUDIES led to three mounting designs. Type 1 is for a free-floating, monolithic 1723 glazing incorporating two novel techniques. A landed shoulder edge with the re-entrant condition was included and edge cushioning between the frame and the glass was eliminated. The Type 2 attachment is more conventional, using a silicone rubber cushion and seal between the free-floating laminated glazing and frame.*

*The Type 3 attachment is an example of the most controversial glass mounting, in that it deliberately transfers tensile loads to the glass by means of bonded side members. But the specimen tests consistently achieved higher loads than were called for in the contract. All three were concerned with 1723 glazing, an alumino-silicate glass.*

THE AIR FORCE is growing in creasingly interested in an almost for gotten aspect of manned aerospace ve hicles—direct vision windows.

Operational and environmental con ditions affecting glazings in futur vehicle designs were presented to 3 representatives from the missile/spac industry by Corning Glass Works at recent symposium.

Corning reported on an Air Forc contract involving the properties o alumino-silicate glass (CGW Cod 1723). The maximum service tempera ture of this material is 900°F, but be cause future requirements will go fa beyond this, the work also covere high silica glass (CGW Code 7900) an fused silica (CGW Code 7940).

A companion program involvin high-temperature glazing edge attach ments and techniques under develop ment at Narmco Industries, Inc., wa included in the presentation.

• **Psychological necessity**—In th opinion of designers and fabricators the need for visual reference in futur manned aerospace vehicles is nonexist ent from a structural and aerodynamica viewpoint. But there is almost universa agreement that some degree of externa vision is a psychological must.

For this purpose, radar, periscopes television and direct vision may be in cluded. With the exception of radar, a of these require some sort of trans parent skin area on the surface of th vehicle.

Forgetting the pilot for a momen there will always be a need for mor transparent and semi-transparent ski areas for cameras, solar batteries, an infrared and ultraviolet detectors.

The optical quality of these glazin materials must be excellent if they ar used for high-resolution optical instru ments. This means that no distortion may be introduced by the mounting air frame loads.

In the vehicles in question, no un necessary protrusions from the basi fuselage lines can be tolerated. Thu

the glazings involved will conform to the vehicle—large radii of curvature and small degree of arc.

The intrinsic strength of glazings is quite high, but the working tensile strength is usually very low, because of stress concentration effects caused by minute surface imperfections or improper mounting. The larger and heavier the glazing, the lower the allowable working stresses will be. Corning points out that maximum working stresses must be determined for each specific application.

In a composite structure such as a pilots' enclosure, the design must keep to a minimum stress concentration due to mounting and attachment joints. In addition, the expansion characteristics of the glazing and framing materials should be matched as closely as possible over the expected temperature range. Where this cannot be done, compressive stresses should be induced on the glazing during the duty cycle.

Pressures from opposite surfaces of mounting frames should be uniform around the periphery end, and an intermediate resilient material should be used to prevent direct metal contact. To avoid stress concentrations and abrupt loading conditions, the edges of the frames glazings should be chamfered or radiused and the corners well rounded.

Localized temperature gradients between opposite surfaces of a glazing can induce excessive stresses. But the linear coefficients of the glasses under consideration are low enough so that the maximum stress at the surface, especially with a controlled temperature gradient, should not be great enough to cause failure.

• **Heat factors**—The thermal environments experienced by a vehicle obviously depend upon its mission. The maximum operating temperature of any craft utilizing transparent enclosures is limited by either the glazing or the sealing and framing materials. The qualities of the three glazing materials under investigation lead to the assumption that the major thermal limitations will be imposed by the surrounding structural media.

The aerodynamic load imposed on a particular external glazing will be determined by its location on the vehicle and by the vehicle configuration. The actual loads are difficult to predict in advance of flight-testing; the designer must include both near frontal and non-frontal capabilities. Where positive compartment pressure is indicated, several other problems are introduced. If a multiple glazing system is used, compartment pressure could be retained by the inside glazing, where the temperature is lower and conventional organic sealant materials can be employed.

## Alloys Under Consideration for Framing Materials

| ALLOY GROUP | ALLOY | DENSITY (LB./CU. IN.) | PRINCIPAL COMPOSITION | SOURCES |
|---|---|---|---|---|
| ALUMINUM | Not Covered | | | |
| MAGNESIUM | Not Covered | | | |
| ALLOY STEEL | Vascojet 1000 | 0.280 | Fe-Cr-Mo | Vanadium Alloys |
| | Potomac A | 0.283 | Fe-Cr-Mo | Allegheny Ludlum |
| TITANIUM | Comm. Pure | 0.164 | Ti | — |
| | 6A1-4Va | 0.161 | Ti-Al-Va | Armour Research |
| ST. STEEL | AISI 310 | 0.284 | Fe-Cr-Ni-Mn | — |
| PRECIPITATION HARDENED S.S. | 17-7Ph/TH1050 | 0.277 | Fe-Cr-Ni | Armco |
| | Ph15-7Mo/RH950 | 0.277 | Fe-Cr-Ni-Mo | Armco |
| IRON-BASE HIGH-TEMP. | A-286 | 0.286 | Fe-Ni-Cr | Allegheny Ludlum |
| NICKEL-BASE HIGH-TEMP. | Hastelloy X | 0.297 | Ni-Cr-Fe-Mo | Haynes Stellite |
| | R-235 | 0.310 | Ni-Cr-Fe-Mo | Haynes Stellite |
| | René 41 | 0.296 | Ni-Cr-Co-Mo | General Electric |
| | Inco 700 | 0.295 | Ni-Co-Cr | Inco |
| | M-252 | 0.298 | Ni-Cr-Co-Mo | Carboloy, G.E. |
| | Udimet 600 | 0.286 | Ni-Cr-Co | Utica |
| COBALT-BASE HIGH-TEMP. | L-605 | 0.330 | Co-Cr-W-Ni | Haynes Stellite |
| REFRACTORY ALLOYS | O.5% Ti-Molybdenum | 0.369 | Mo-Ti | Climax Molybdenum |
| | F44/F48 Columbium | 0.368 | Cb (?) | General Electric |

Depending upon glazing size and configuration, the loads imposed by compartment pressure will take the form of plate bending, hoop tension, or a combination of both. For the latter two conditions, a definite load-carrying edge attachment member is needed.

• **Insulation or heat sink**—With maximum skin surface temperatures ranging from 900° to 2000°F for periods of a few minutes to several hours, methods must be found to restrict or dissipate heat flow. The engineers contacted by Corning during the survey completely endorsed a multiple-glazed system.

But Corning specialists say that such a system can adequately reduce the heat flow only by resorting to an exorbitant number of glazings or incorporating cooling or insulating devices.

These include metal shields which cover the glazings during peak heating; circulation of air or liquid coolants between glazings, heat-reflective coatings and combinations of all three.

The use of metal shields in frontal applications can be considered a necessity. But circulating media, gaseous or liquid, introduce the problem of seals. If the medium is liquid, the glazing will be subjected to added inertia and surge loads and a possible change in the index of refraction caused by density variations. Since it is almost impossible to heat a liquid uniformly, the convection currents would degrade the optics of the system. To a lesser degree, the same effects would hold with gaseous coolants.

Depending on the material, the primary means of heat transfer through a glazing is either by direct radiation transmission or absorption and reradiation of the thermal energy. In either case, the obvious method or retarding transfer would be through infrared reflective coatings. But these coatings tend to reduce visible light transmission and increase surface reflectance. Methods are being devised to increase the IR reflectance of the coatings and eliminate the absorption of certain IR wavelengths. These results will have a definite influence on edge attachment and mounting system design.

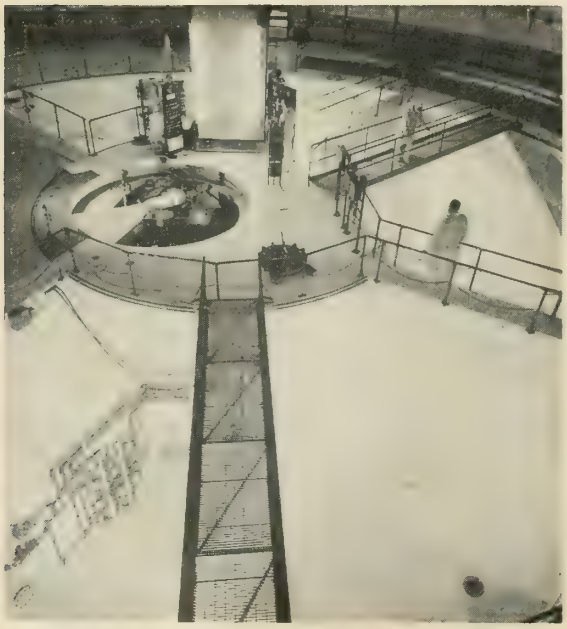
Another path for heat transfer is by conduction through the frame surrounding the glazings. Since the aerodynamic boundary layer comprises a source of an essentially infinite amount of heat, this can be a problem of some magnitude. Due to the high temperatures and long soak times involved, simple heat sink devices or thermal insulation systems will not, by themselves, provide adequate cooling. Incorporation of long, small cross-sectioned heat paths and thermal barriers, together with a circulating liquid coolant, can offer a satisfactory solution.

Differential thermal expansion, thermal shock and stresses were also considered. The glasses in question offer no problems in themselves in this area: it is the mountings that will cause trouble.

• **Materials compatability**—The choice of materials for elevated temperature glazing installations is depend-

*(Continued on page 43)*

# NASA Puts New Reactor to Work



EFFECT OF RADIATION on materials at liquid hydrogen temperature of −428°F will be one of the first problems to be investigated by NASA's new Plum Brook Reactor at Sandusky, Ohio, views of which are shown in the accompanying pictures. Above, a Hot Lab technician operates an underwater handling tool while another removes a control rod from the reactor to an underwater storage area. At right is the interior of containment tank. The operator at upper center is running hydraulic tests to determine water flow distribution in the reactor core. During reactor operation, the pie-shaped area will be filled with about 25 ft. of water.

Other experiments to be scheduled in the early phase of reactor operation will determine the effects of radiation on material corrosion rates at high temperatures and on sensitive electronic components. All experiments will have bearing on plans for the Project *Rover* nuclear rocket or the *SNAP* series of nuclear space powerplants, both of which are under the combined sponsorship of NASA and the Atomic Energy Commission.

Under a license granted by the AEC, NASA is beginning to operate the reactor on a low-power calibration basis. After several months of operation at low power, it will move up to full power of 60 thermal megawatts. The reactor is cooled and moderated by light water, with a primary beryllium reflector and a secondary water reflector. The core consists of 27 aluminum-uranium rods. ■

# RCA 110 Control Computer

## masters 3,000 checkout or control points per second..."as is"!

For space age requirements in checkout, data reduction and control, no other computer anywhere near the price equals the RCA 110.

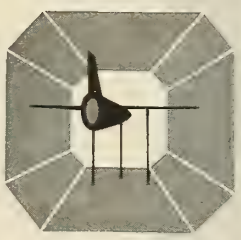
A solid state system utilizing circuits and components proved in thousands of hours of computer use, the RCA 110 offers capabilities that range from checkout and logging to complete real-time control of missiles in flight. *Without modification*, the Computer will exceed the requirements of most data reduction or control problems. Custom variations can be provided to fit any special job.

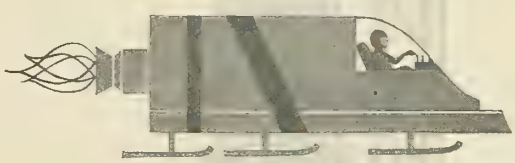
Here are a few highlights of the RCA 110's performance:

- Can operate on-line in missile ground control and checkout systems to address, monitor, analyze and control digital or analog signals at rates up to 3,000 signals per second.
- Computer speed and buffering are so well planned that the RCA 110 stays far ahead of input/output devices and signals in most data reduction, checkout and control applications. For example, memory cycle is 9.7 microseconds.
- Powerful automatic priority interrupt feature provides "first things first" control. During operation the RCA 110 checks each input/output device, notes calibration deviation, and adjusts the program accordingly.
- Complete self-checking routines inspect for proper performance at all times.

The RCA 110 is designed and built to operate at maximum efficiency under the most rugged conditions, and on the most complex real-time problems. Cost is less than any comparable electronic control computer available.

For detailed information and specifications, write Electronic Data Processing Division, RADIO CORPORATION OF AMERICA, 21 Strathmore Road, Natick, Mass.





**COMPARE THESE PERFORMANCE SPECS**

*Speed*—including access time and staticizing, adds in 56 microseconds, multiplies in 728, divides in 868. *Instructions*—one address (limited two address), 7 indexable address modifier registers, 71 wired-in instructions. *Number System*—fixed point, binary or binary coded decimal. 24 bit word length, word time 28.89 microseconds. *Working Storage*—magnetic core, coincident current, variable in size from 256 to 4096 words, 8 high-speed input-output registers, clock frequency 936 kilocycles. *Bulk Storage*—magnetic drum, 3600 rpm, 4096 to 160,000 or more words, 8.3 milliseconds average access time, 200 kilocycle transfer rate, up to 12 buffer tracks for input-output. *Size*—82" high, 34" deep, 105" long. *Typical Power Input*—5 kva, 220 volts.

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# Automatic Abort for Mercury-Atlas

***Astronaut safety system predicts catastrophic failures in Atlas booster and initiates abort sequence to separate capsule***

NEW YORK—Safety of the *Mercury* astronaut during launch and boost will be guarded by a 36-lb. electronic system that can react 100 times faster than a human.

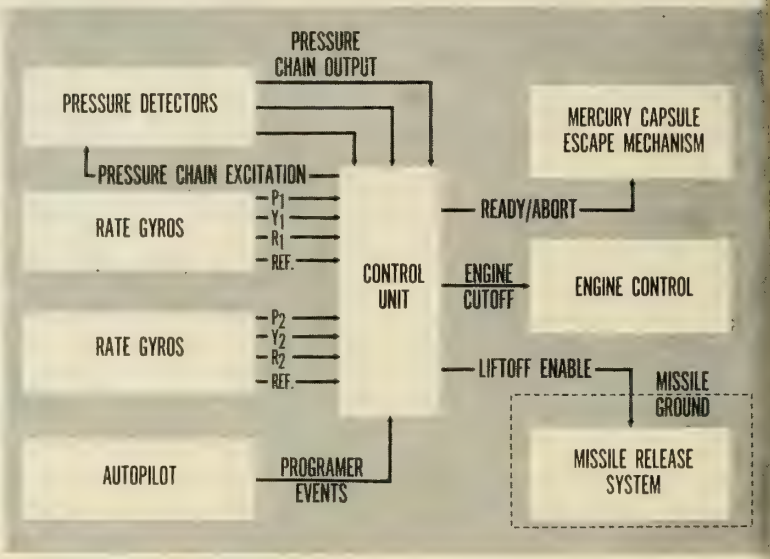
The system, called ASIS—for abort sensing and implementation—will sense and predict failures that might endanger the astronaut's life. When such a failure occurs, ASIS will initiate an abort sequence to separate the capsule from the missile and propel it safely away from a possible explosion.

First details of the system, developed by Convair Astronautics, were revealed in a paper presented here at the recent Institute of Radio Engineers Convention.

T. A. Heinsheimer, Convair engineer who presented the paper, said the ASIS was incorporated in the *Mercury-Atlas* so that no catastrophic failure of the missile could endanger the manned capsule. He said built-in redundancy and self-checks make the system itself as nearly failure-proof as can be designed.

Development of ASIS was based on data from *Atlas* flight tests, static firings and computer simulations which indicated that certain critical subsystems aboard the missile could be monitored to predict catastrophic failure. The interval between a subsystem malfunction and the resulting failure can be so short, however, that no human command decision to abort the mission can be made quickly enough; a fully automatic decision-making system must be used.

During flight, ASIS monitors performance of the propulsion, pneumatic, electrical, hydraulic, and flight control subsystems at critical points throughout the missile. The monitoring signals are continuously fed into the ASIS control unit mounted in the missile pod. This unit performs all necessary logical operations upon these signals and makes the abort decision. If all input signals are normal, the control unit indicates a "ready" condition. Should one or more of the monitored parameters deviate from pre-established limits, the control unit generates the "abort" command.




*ASIS MONITORS all critical missile parameters to predict impending failures. If measurements go outside preset limits, it automatically initiates capsule escape.*

ASIS is designed with a high degree of redundancy—both in the electrical circuitry and in the monitoring electro-mechanical sensors—so that it will not generate an abort command due to a failure in its own system. Such an inadvertent abort command would be indistinguishable from a legitimate command and would, therefore, initiate the capsule escape sequence. There must be no system failure which could cause an erroneous abort command to be sent, or prevent the system from operating properly in the event of an actual missile malfunction.

Components of high reliability and proven flight performance were selected for the system. Extensive failure mode analyses were conducted in order to select components whose failure (though unlikely), would be in a definite direction. In addition, suitable electrical and mechanical derating factors were applied to each component.

Each critical parameter is monitored by dual sensors—or transducers—whose outputs are channeled to the control unit.

Signals from the autopilot programer initiate the arming and disarming of several sensor signals as well as the arming and disarming of some of the ASIS functions. The system is armed by a signal from the programer at missile liftoff after which it can command capsule escape whenever warranted. At liftoff plus thirty seconds the programer arms the system's engine cut-off capability so that an abort command will automatically shut down the *Atlas* engines.

At staging—when the booster section is jettisoned and propulsion maintained by sustainer solo operation—transducers which monitor booster engine performance are no longer needed, and are therefore no longer observed by the control unit. At the same time, changes are made in some of the parameter threshold levels (the level a parameter must reach before an abort condition is present). In this way,

the control unit is kept informed of the progress of the flight and is able to properly evaluate missile performance at any time during flight.

The outputs of the control unit are the ready/abort signal to the *Mercury* capsule escape mechanism, the engine cutoff command, and the liftoff-enable signal. Liftoff-enable is sent while the missile is still on the ground. After main-stage ignition—while the missile is still held down by the launcher—all parameters monitored by the control unit reach their normal operating values, and the control unit goes into the "ready" condition.

At this time a liftoff-enable signal is sent through a missile umbilical to the missile release system. When this signal, and a number of others sent from other missile checkout systems, are all received by the release system, a signal is sent to the launcher and the missile is released. If the liftoff-enable signal is not sent by the control unit due to a fault in some area of missile performance, release will not occur and the engines will shut down automatically.

Parameters monitored by the control unit include a group of pressures which determine proper operation of the missile pneumatic, hydraulic, and propulsion systems: fuel injection pressures of the three engines, LOX tank pressure, the differential pressure across the main bulkhead, and the sustainer hydraulic pressure.

The outputs of two sets of rate gyros are used by the control unit to monitor performance of the missile stabilization and control system. Each set consists of three rate gyros to detect rotational rate about the pitch, yaw and roll axes. The final parameter monitored by the control unit is the missile a-c line voltage, sensed within the unit.

• **Rate sensing**—Each of the six rate gyros is monitored by an over-rate detector circuit. The output of this detector is zero as long as the gyro output is within safe limits. If, however, the gyro output becomes excessive, indicating excessive missile rotational rate, the output of the detector switches to seven volts. The detector is, in effect, an analog-to-digital converter which provides an output voltage only when an abort condition is to be indicated.

• **Pressure sensing**—Each pressure switch is wired in parallel to its redundant mate—an arrangement resulting from failure mode analyses made on the switches used. Each set of switches is then wired in series and the entire chain energized with a 35-volt signal stepped down from the 400 cps 115-volt missile power supply.

At staging, the closure of the booster cut-off relay contacts within the control unit short-circuits the fuel pressure switches in the two booster engines, thereby bypassing them in the chain. At the same time, a low-pressure LOX sensor is added to the chain in parallel to the LOX pressure switches already there. The addition of the LOX pressure switch compensates for the reduction in pressure required during sustainer solo operation.

Each switch remains in the shorted position as long as its excitation pressure is within acceptable limits. Each therefore, completes its link in the chain and, when all pressures are normal, 35 volts is seen by the pressure chain output transformer. The output of the transformer is rectified and then fed through Zener diodes into magamp one-not gates. When the pressure chain is broken by the opening of both switches of a pair, the input to the one-not gates falls to zero and the gates turn on.

• **Line voltage sensing**—Zener diodes are used in the pressurization sensing line to sense the level of the a-c power supply. If the line voltage drops, the 35 volts output of the pressure chain drops proportionately. When the rectified signal through the Zener diodes drops to below their Zener voltage the entire output of the pressure chain is effectively blocked by the diodes. The one-not gates, therefore, sense no input voltages and act as if the pressure chain had been broken by the loss of a monitored pressure.

• **Control unit output**—Outputs of the six over-rate detectors, and the two one-not gates are connected to a pair of two-not gates. The two-not gates are designed to stay in the "on" condition as long as the inputs to both control windings are effectively zero. Should a significant input current excite either of the gate's control windings it switches to the "off" position. An output from any of the eight logical circuits feeding into the two-not gates turns both gates off.

The drop-out of the two-not gate output voltage is the signal recognized by the capsule escape mechanism as the abort command. This drop-out of voltage also results in the de-energizing of the engine cutoff relays in the control unit. If more than 30 seconds have passed since missile liftoff, the engine cutoff capability of the ASIS is armed, and a 28-volt signal is sent to the engine control system to shut down the *Atlas* engines. ⁂

*NO ASIS was needed in completely successful Mercury Atlas 2 shot Feb. 21.*



# Designing Data Display For Pilot of Spacecraft

by Charles Owen Hopkins
and
D. K. Bauerschmidt
*Hughes Aircraft Company*

SENSING, PROCESSING and display of the data astronauts must have in order to participate in guidance and control will make up a significant portion of the electronics aboard manned hypersonic vehicles.

The astronaut will need information on vehicle orientation, flight path, orbital parameters and environment—information which is reliable, easy to interpret, highly accurate, and presented with small weight and volume.

Unfortunately, the equipment—and in some cases, the basic techniques—necessary to attain this are not available. The difficult task of conceiving, developing, testing and evaluating the techniques and equipments is in the hands of the designers.

Recent studies indicate that the human operator's best contribution is in command or system management.

The astronaut's primary job will be to determine the state of the system and evaluate it in relation to the planned mission requirements and the various alternative programs provided. When he has done this, he will designate alternate subsytem operations and/or alternate basic system programs to be carried out.

• **Evaluating the system**—First, the pilot senses the information. His primary sources are visual and, to a considerably lesser degree, auditory displays of already processed information. The auditory displays mostly involve communications and system malfunction warnings, although this information may also be displayed visually.

In some instances, information about the state of the system may be sensed directly. The pilot may "feel" the vehicle's condition by his own sense of balance or muscular movements. Or he may determine the vehicle's path by looking through viewports and periscopic devices.

Secondly, the human operator must assimilate sensed information with previously acquired information—a function for which the human is uniquely qualified and may be far superior to any machine. He can then predict the probability of success of the current program.

His next function may be to designate an alternate mode of operation for a subsystem, or an alternate basic system program for a subsequent mission phase. If necessary, he may designate an alternate program that will terminate the planned mission but result in recovery of the system.

• **Other jobs**—Although these tasks will constitute his most important responsibility, the pilot may be given additional assignments. These may include manual operation of auxiliary sensing devices, transmission of manually acquired information to the system requesting certain information from the system, and—to a limited degree—processing manually acquired data by means of charts, graphs, tables and perhaps a special-purpose hand-operated computer.

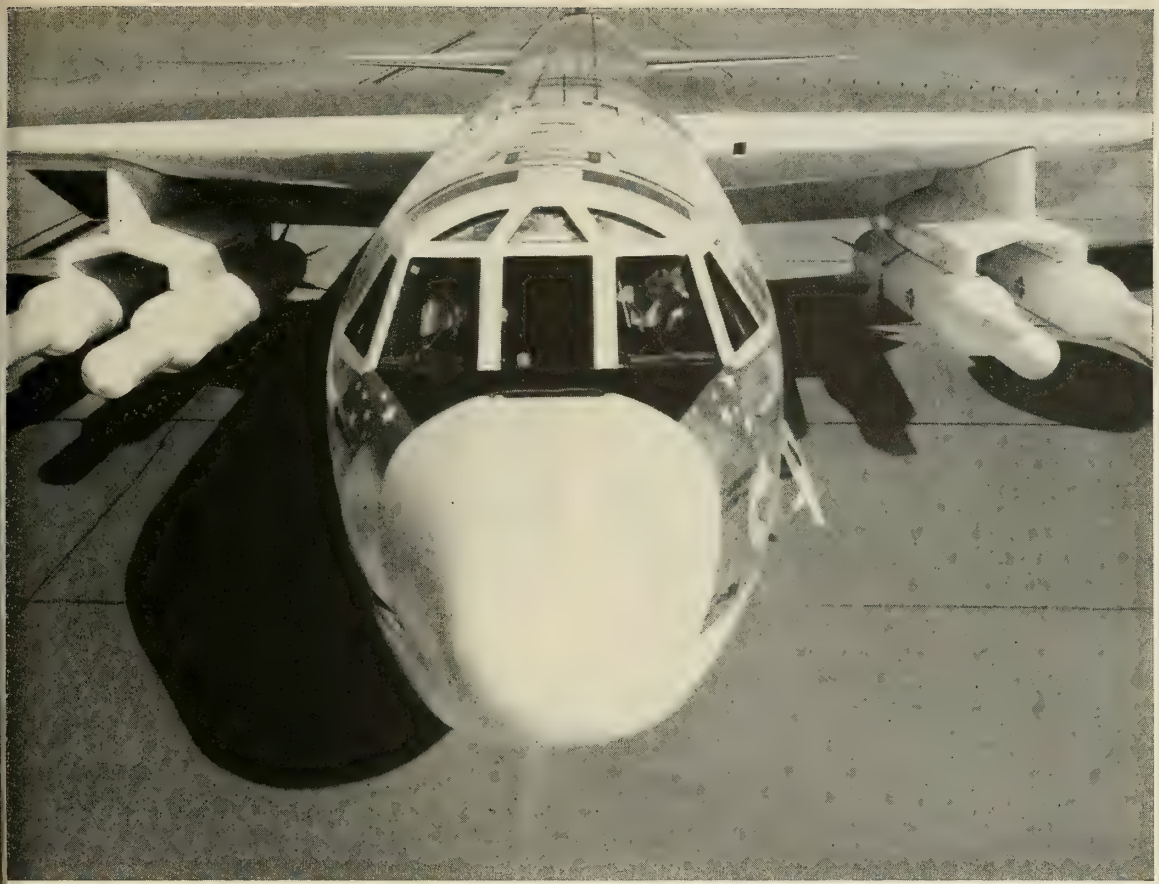
Under very special conditions, the human operator may be required to function as a continuous controller of vehicle output, regulating vehicle attitude and thrust. This would most likely occur during the final closing maneuver of a rendezvous mission phase or as an emergency backup mode of operation.

• **Kinds of information**—Categories of information the human operator will need are:

—Current system-mission status: vehicle flight path, vehicle attitude, and subsystem and component status. These subclasses of information may be further subdivided; for instance, flight path information may be either orbital flight path information or atmospheric flight path information, depending upon the mission phase. Orbital flight information may be either earth-referenced for near-earth orbits or target-satellite-referenced during part of the rendez-




*Figure 1. Orbital Situation Display*



**MISSILE BOMBER.** New "H" model is latest version of famous Boeing B-52 missile bomber, most versatile long-range weapon system in U.S. Air Force arsenal. B-52H here carries mock-ups of four Skybolt air-launch ballistic missiles. B-52s can also carry supersonic Hound Dog missiles for in-flight launching toward distant targets. Flying high or low, B-52s will provide an almost undetectable launch pad for missiles. They can also carry regular load of gravity bombs, and strike up to five targets on single mission.

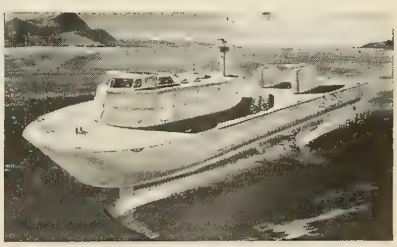
# *Capability has many faces at Boeing*



**RESEARCH STATION.** Model of space research station designed by Boeing to accommodate12 men and remain in earth orbit, serving as research station or interplanetary launch site.



**SPACE CHAMBER.** Boeing multi-stress chamber simulates six conditions of space travel in research to develop protective environments required for space vehicle crews. Chamber will also be used to test conditions in moon stations.



**"FLYING" BOAT.** Drawing of 115-foot hydrofoil craft Boeing is building for U.S. Navy. Riding out of water, hydrofoil will "fly" on underwater wings at speeds up to 45 knots. Powered by two 3000-hp gas turbine engines, craft will be the biggest hydrofoil ever built.

**BOEING**




*Figure 2: Transfer Display*

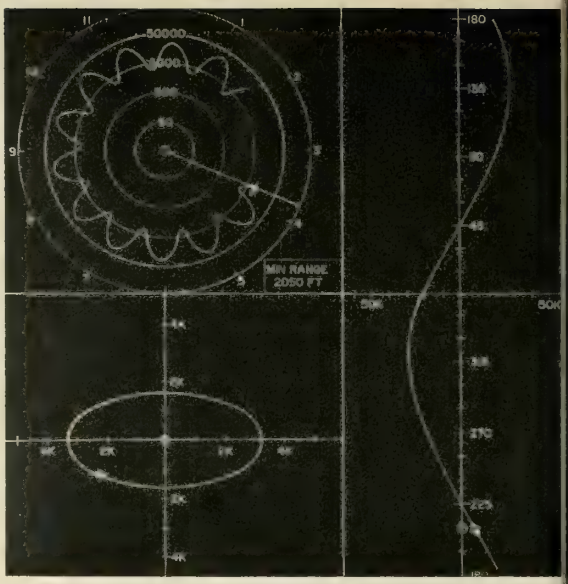



*Figure 3: Rendezvous Display*

vous phase of a ferry vehicle mission.

—Requirement or command: time of next thrust application, the required velocity increment ($\Delta V$) for next maneuver, command attitude angles and rates, etc.

—System capability: available energy in various forms and remaining supply of life-support stores. Life support becomes important since its capability may influence alternate modes of operation or alternate mission programs.

• **A specific case**—Each mission, each system, will have its own information requirements. Here is an example of how Hughes Aircraft Co. designed displays to meet a set of specific requirements:

The mission may be summarized as follows: The vehicle is launched from the earth and injected into a circular polar orbit at an altitude of approximately 450 miles. This is followed by a minimum energy transfer to effect a rendezvous with a target satellite in a coplanar orbit at an altitude of 500 miles. After making soft contact with the target satellite and transferring stores and/or personnel, the vehicle departs from orbit at the appropriate time, safely re-enters the earth's atmosphere and glides to a landing at a designated base.

The major mission requirements are (1) initiation of powered flight, (2) attainment of a planned orbit, (3) rendezvous with a target satellite, (4) departure from orbit, (5) attainment of aerodynamic flight, (6) arrival in the vicinity of the landing base, and (7) controlled landing at the base.

This example will concern itself with steps 1) through 3), beginning with cutoff or burnout of the injection-stage rocket motor.

System requirements for this mission phase are (1) stabilization of vehicle attitude, (2) initiation of appropriate vehicle pitch rate, (3) determination of orbital elements and related parameters, (4) minor rotation of the plane of the orbit, and (5) transfer to the target satellite orbit. The system functions, automatic or manual, which must be performed are summarized in Table I.

In the interest of brevity, requirements and functions will not be discussed in detail.

Specific information required by the human operator is presented in Table II.

• **Three sources**—Hughes has proposed three displays (Orbital Situation Display, Transfer Display, and Rendezvous Display), intended to provide the operator with both quantitative and pictorial information needed for orbit adjustment and transfer.

Before a transfer orbit is initiated, the primary orbital flight path information to be displayed to the operator is referenced to the earth (Fig. 1). This display presents in a pictorial manner, by means of cathode-ray traces on a 12 x 12 in. viewing screen, the size and shape of the target-satellite and the ferry-vehicle orbits, as well as the instantaneous positions of each vehicle in its respective orbit and predicted positions of future thrust applications. Orbital parameters for both the ferry vehicle and the target satellite are presented quantitatively by means of a column of alpha-numeric readouts along the right-hand edge of the display.

The pictorial presentation shows th orbital paths of both the ferry vehicl and target satellite against a backgroun of fixed display elements representin the earth, the limit of effective atmos phere, and altitude increments abov the earth's surface. The earth is repre sented by a ½-in.-diameter circle in th center of the pictorial display area. Th altitude scale consists of concentric ring labeled 1 through 5 representing alti tude at 100-mile intervals up to 50 miles. The limit of the effective atmos phere, based upon an assumed atmos pheric model, is shown by a fuzzy circl at approximately 60 miles altitude.

The orbital paths of both the ferr vehicle and target satellite are presente against the fixed altitude rings b cathode-ray traces. Instantaneous pos tion of the ferry vehicle in its orbit i shown by a small filled circle with a arrow pointing in the direction of trave in the orbit. A small open circle ind cates the instantaneous position of th target satellite.

A small x indicates the point in th ferry vehicle's orbit where the ne thrust application is to be made—in thi case, for initiating a transfer orbi Emanating from the x is a color-code arc representing the transfer orbit path predicted to result from the appl cation of thrust. The transfer orbit path arc terminates at the predicte point of interception of the target sate lite. This is shown by a short bar inte secting the target orbit trace at a rig angle. This point is the apogee of th transfer orbit, where a thrust applic tion must be made to attain circula

## TABLE I. System Requirements and System Functions During Rendezvous Phase

| SYSTEM REQUIREMENTS | SYSTEM FUNCTIONS |
|---|---|
| Stabilize Attitude | Sense vehicle attitude conditions.<br>Determine corrective attitude jet thrust.<br>Apply corrective thrust. |
| Initiate Pitch Rate | Determine correct pitch rate.<br>Determine required thrust.<br>Apply thrust to initiate pitch rate. |
| Determine Orbital Elements | Determine orbital elements or related parameters.<br>a. Size and shape of orbit.<br>b. Position of vehicle in orbit.<br>c. Orientation of orbit in space. |
| Rotate Orbit Plane | Determine time of arrival at node.<br>Determine amount and direction of required thrust.<br>Apply thrust to rotate plane of orbit.<br>Repeat attitude of stabilization if necessary. |
| Transfer to Destination Satellite Orbit | Determine critical central angle between satellites.<br>Determine time of occurrence of critical central angle.<br>Determine required thrust magnitude.<br>Apply thrust to initiate transfer ellipse.<br>Repeat attitude stabilization, if necessary.<br>Determine arrival time at apogee of transfer ellipse.<br>Apply thrust at apogee to achieve circular velocity.<br>Repeat attitude stabilization, if necessary. |

orbital velocity at the target satellite's altitude.

The quantitative information display has been arranged so that readouts of closely related information are grouped together. At the top of the column and enclosed within a square are three readouts of information concerning the height of the ferry vehicle's orbital path over the earth. These are labeled APOGEE, ALTITUDE, and PERIGEE—indicating the altitudes to the nearest 1/100 nautical mile of the apogee of the orbit, the instantaneous altitude of the vehicle and the perigee of the orbit, respectively.

Immediately beneath the square enclosing the altitude information are four readouts presenting information about size and shape of the orbit, the orbital period, and the position of the ferry vehicle in the orbit. Orbital size and shape are presented by the readouts labeled SEMI-MAJ AXIS, which indicates the length of the semi-major axis of the orbit to the nearest 1/100 mile, and ECCENTRICITY, which presents the orbital eccentricity to six decimal places. The ORBITAL PERIOD readout presents the time required to complete one orbit to the nearest 1/100 minute. Instantaneous position of the vehicle in its orbit as given by the central angle measured in the direction of vehicle movement from the ascending node is presented to the nearest 1/10 degree by the CENTRAL ANGLE readout.

Next in the readout column is a set of four readouts, enclosed by a square, displaying the orientation of the orbital planes of the ferry vehicle and the target satellite. The readouts indicate the angles of inclination and the right ascension of both the ferry vehicle and the target satellite to the nearest 1/100 degree. Following these indications, the angle between the ascending node and perigee measured in the direction of vehicle travel in orbit is indicated by the ARGUMENT OF PERIGEE readout to the nearest 1/100 degree.

The two readouts in the next square present information on angular relationships between two satellites. The current central angle between the ferry vehicle and the target satellite, measured from the ferry vehicle in the direction of travel in the orbit, is presented to the nearest 1/100 degree. So is the value of the central angle between vehicles at which thrust must be applied by the ferry vehicle in order to initiate a minimum-energy transfer ellipse to intercept the target satellite.

The readout labeled HOHMANN FLIGHT TIME, located at the bottom of the column, presents to the nearest 1/100 minute the predicted time required to complete the transfer orbit (Hohmann orbit).

After the ferry vehicle is in the transfer orbit the flight path information of primary interest is that shown relative to the target satellite. The transfer display shown in Fig. 2 presents this type of information.

The reference system used for specifying the position of the ferry vehicle relative to the satellite is a moving Cartesian coordinate system with its origin at the center of the target satellite. The y-axis is directed along the target satellite's radius vector. The x-axis is normal to the radius vector in the plane of the orbit; the z-axis is normal to the plane of the orbit. The position of the target satellite in its orbit is specified in degree of central angle ($\eta$), measured from the ascending node in the direction of satellite travel.

The Transfer display has been divided into three parts in order to show clearly on a two-dimensional display surface the relationship between the satellites in the three-dimensional space defined by the coordinate system.

A rectangular area located in the lower left part of the display shows the predicted path of the ferry vehicle, relative to the target satellite, projected onto the plane of the satellite orbit. Because the fixed display elements include an intersecting horizontal and vertical line representing the x- and y-axes of the coordinate system, this part of the display is called the x-y presentation. A small circle at the origin represents the target satellite. The index marks represent distance increments of 10,000 feet along the axes.

The predicted path of the ferry vehicle relative to the target satellite, as computed from the orbital elements of both the ferry vehicle and the target satellite, is shown by a cathode-ray trace against the fixed reference axes. Apogee of the ferry vehicle transfer orbit, which is also in this case the predicted point of thrust application for the establishment of circular orbital velocity at the altitude of the target satellite, is shown by means of a short bar intersecting the predicted path at a right angle. If the instantaneous position of the ferry vehicle is located within the portion of the orbital path shown, it is represented by a small filled circle with an arrow pointing roughly in the direction of vehicle motion.

A Z-$\eta$ presentation occupies a rectangular area 4 in. wide and 10 in. high at the right side of the display. The vertical line represents the plane of the target satellite orbit, and the horizontal line represents the earth's equatorial plane. The intersection of these lines represents the ascending mode of the target satellite orbit. The scale on the vertical axis represents central angle in degrees measured from the ascending mode in the direction of satellite travel. The index marks on the horizontal axis represent distance increments of 10,000 feet from the plane of the orbit in a direction normal to the orbit (z-scale).

The instantaneous position of the target satellite in its orbit is shown by a small circle that moves along the vertical line. The predicted path of the ferry vehicle for one complete orbit is shown in terms of its deviation from the destination satellite orbit by means of a cathode ray trace. If the ferry vehicle transfer orbit and the target satellite

## TABLE II. Specific Information Required by Operator During Rendezvous Phase

| GENERAL SYSTEM REQUIREMENTS | CATEGORY OF INFORMATION | | |
|---|---|---|---|
| | SYSTEM-MISSION STATUS | REQUIRED OR COMMANDED | CAPABILITY |
| Attitude Stabilization | Pitch, roll and yaw angles and rates.<br>Status of stable platform, auxiliary sensors, computer, etc. | Pitch, roll, and yaw angles and rates. | Amount of attitude control system propellants remaining. |
| Orbit Adjustment | Burnout conditions (h, V, vpa, time). Computed orbital elements and related parameters.<br>Pictorial orbital relationships (referenced to earth).<br>Instantaneous position over earth (pictorial and Lat.-Long. readouts.)<br>Time remaining to next thrust. | Desired size and shape of orbit and acceptable variations.<br>Magnitude, direction and time of application of next thrust. | Main rocket engine propellants:<br>1. Amount remaining.<br>2. Amount required for next thrust.<br>3. Amount required for safe de-orbit after next programed thrust.<br>4. Reserve. |
| Orbit Transfer | Computed orbital elements and related parameters for vehicle and target satellite.<br>Pictorial orbital relationships (referenced to target satellite).<br>Range to target satellite (radar or optical).<br>Collision warning.<br>Time remaining to next thrust. | Critical central angle for starting transfer ellipse.<br>Magnitude, direction, and time of application of next thrust. | Main rocket engine propellants: (same as in cell above).<br>Predicted transfer orbit.<br>Predicted range to target satellite. (Minimum range and variation of range with time.) |

orbit were coplanar, the trace showing the predicted path of the ferry would be coincident with the vertical line on the display. For orbital plane differences causing deviations within the z-scale on the display, the ferry's predicted path trace will be a sinusoid varying about the y-axis, as shown in Fig. 2. The instantaneous position of the ferry vehicle relative to the target satellite is shown on the predicted path trace by a small filled circle with an arrow pointing in the direction of vehicle travel.

The third part of the Transfer Display, an R-T presentation in the upper left corner, shows predicted ferry-vehicle to target-satellite range variations as a function of time for the next 10 hours. The fixed display references are six concentric circles. The outermost circle contains 48 equally spaced index marks representing 15-minute increments of time. The index marks at the conventional positions are labeled 1 through 12. The innermost circle represents the target satellite. The remaining four circles represent ranges from the target satellite in feet on a logarithmic scale.

Present time is shown by the position, relative to the clock markings, of the end of a cathode-ray trace that appears as a radial line. The predicted range variation as a function of time for the next 10 hours is shown by a cathode-ray trace emanating from the radial line. Instantaneous range to the target satellite is indicated by the position relative to the fixed range circles of a filled circle with an arrow located on the radial line. A numerical readout of the predicted minimum range for the given time period is located in the lower right hand corner of the R-T presentation.

During the terminal part of the orbit transfer it is desirable to display predicted ferry vehicle orbital path information with greater precision. Therefore, the display scale factor on the x-y presentation is changed to 2000 feet to the inch as compared to the scale factor of 10,000 feet to the inch on the Transfer Display. The display with the greater sensitivity is then referred to as the Rendezvous Display.

A typical rendezvous situation as it might be displayed on the Rendezvous Display is shown in Fig. 3. The orbit transfer has been completed by means of the second thrust application, but a closing maneuver has not been made. Present range to the target satellite is about 6000 feet. The orbital elements of the two satellites are not matched exactly but their orbital periods are approximately equal. ⁂

# Calco Pump Vital to Titan's Guidance

DEEP WITHIN the *Titan* guidance system is a small but critical immersible pump motor developed for the A. C. Spark Plug system by Calco Manufacturing Co., Addison, Ill.

Calco was asked to design and manufacture a motor capable of delivering 2500 hours of continuous duty. The watt input and power factor were considered critical because other sources in the system were programed for explicit usage. The power source was to be 115V. a-c, single phase.

The pump motor was to pump a fluorochemical through the gimbal at a given flow and pressure, while completely immersed. The continuous duty motor temperature rise was to be less than 40°F.

All components receive 100% inspection under a 30 power microscope, and are then cleaned in an ultrasonic cleaner with Freon 113. No components, once cleaned, are handled without the use of decontaminated gloves.

Special test equipment was procured to satisfy exacting performance requirements. Readings of power frequency and watt input were made within 0.05% accuracy.

With a special end bell, diffuser plate and impeller, the pump motor was found to give maximum performance.

A motor fully meeting design requirements was furnished in just 90 days. It was selected as the result of 28 prototypes, covering six engineering designs. This final version has a power source of 8.4V. a-c, two phase, instead of the 115V. a-c, single phase originally planned, plus the lowest watt input possible to achieve.

Life tests duplicating actual service conditions show to date a continuous run of 24 hrs. a day, 7 days a week, for a total of 10,000 accumulated hours—with an expectancy of 15,000 hours, a performance far superior to the original requirement.

A. C. Spark Plug engineers have reported that checks made every 200 hours, after 10,000 hours of life, show no dimensional wear. ⁂



# He solved this puzzle by taking it apart!

Like oil and water, extreme precision and "complete" mobility resist combination in tracking radar antennas. Designing for one of these characteristics "automatically" precludes the other. *That* was this AMF Engineer's puzzle—to put *both* precision *and* mobility in an antenna for duty with the Marine Corps.

He solved the puzzle, literally, by taking apart the solution—AMF's TPQ-10 antenna—into 10 rugged, portable, submersible, precision-fabricated packages. TPQ-10 is designed for helicopter transport. Each component can be dropped in water; it will come up for more. The packaged antenna on its pallet can be dropped on land from 3 feet without impairing precision.

Each component can be *picked* up—the largest weighs 425 lbs.—and can be handled by 3 men. A crew of 6 can put TPQ-10 together in 20 minutes with one standard wrench.

Among the design innovations that solved the puzzle is a "piggyback" gear arrangement that puts both azimuth and elevation drives in one package. Result: almost half the parts and weight of separate components. Precision fabrication is typified by the reflector arms, held to a .005" deviation over 45 inches!

*(For unclassified information on early warning and radar antenna systems, write Dept. CS 1, address below.)*

### Single Command Concept

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# U.S. Charts Surface of Moon

***Geological survey's mapping for NASA and Army Engineers is described at joint meeting of ASP and ACSM in Washington***

**by Charles D. LaFond**

THE LUNAR SURFACE is being given continuous study as a prelude to man's exploration of earth's only natural satellite.

The U.S. Geological Survey (USGS), Department of the Interior, is performing the study for the National Aeronautics and Space Administration and the Army Corps of Engineers. Through comprehensive photogeologic interpretation, it is applying its findings to 1:1,000,000 scale base maps compiled by the Air Force.

The photographs with which much of the USGS activities are concerned are stereo pairs. These are obtained not with widely spaced cameras, as would be expected, but by proper orientation of photographs taken at lunar libration extremes. Even with cameras on opposite sides of the earth, the angular difference would only be about 1.75°. This is insufficient for good stereo viewing.

However, the moon experiences up to a 13° total latitudinal libration and 16° total longitudinal libration over a period of time. Thus, photographs of the moon made at two librations having an angular difference in view of 15° are comparable to those which might be taken from two points in space some 75,000 miles apart. For stereo-photo interpretation, this apparent base line is sufficient to provide the necessary depth.

These details of advanced lunar mapping techniques were presented by Robert J. Hackman, USGS, in one of many papers related to this year's ASP-ACSM conference theme of "Space Mapping."

Over 80 exhibits and scores of papers were offered in this annual joint week-long meeting in Washington at the Shoreham Hotel of the American Society of Photogrammetry (ASP) and the American Congress on Surveying and Mapping (ACSM).

To orient photos, said Hackman, the geometric center of the lunar disc in each pair of photos must be determined, the conjugate image point of each center is located on the complement image, conjugate and geometric centers on each photo are then aligned with the x-direction of the stereo viewer, and finally the pictures are separated for stereo effect.

Lunar stereoscopic models, Hackman admitted, are not geometrically correct because of the small base-distance ratio of the photo pairs. Nevertheless, with photos of maximum libration relief over 1000 feet are discernible. Features down to 100 or 200 feet are obtainable from shadows resulting from very low sun—such as the wrinkle ridges in the maria.

Even with the poor resolution of the photographs and telescopes employed, said Hackman, results of the lunar photointerpretation program are providing a broad framework for use in the future. When photo-reconnaissance rockets obtain more detailed pictures, the geologic maps can be more highly refined.

• **French project**—Another paper by Robert W. Carder described a comprehensive lunar photography program being carried out at Pic-du-Midi Observatory. Located in the Pyrennes Mountains in southern France, the observatory is systematically cine-photographing the entire visible portion of the moon on 9-in. aerial film. These will be used to support construction of 1:1,000,000 Scale Lunar Charts.

Techniques for determining heights of lunar features by shadow measurements, said Carder, have been refined by Professor Zdenck Kopal, University of Manchester, England. Charts have been prepared with 300-meter contours in localized areas with a probable error of 100 meters.

(Carder has directed the Lunar Charting Program of the Aeronautical Chart and Information Center, in St. Louis, for the past year.)

• **Stereo illusions**—Aerial photographic pairs obtained at hypersonic speeds and viewed stereoptically can show surface discontinuities as high as 50 feet where none exist. This and other environmental effects of supersonic and hypersonic speeds on aerial photography were described by J. N. Nielson and F. K. Goodwin of Vidya, Inc. a division of Itek Corporation in Palo Alto, Calif. The division is studying the problem for the Army Engineers' Geodesy Intelligence and Mapping Research and Development Agency (GIMRADA).

Many of the effects of boundary layer and shock waves on the metric distortions introduced into mapping photography, as well as the metric distortion caused by aerodynamic heating of the camera window, were described by the authors. Turbulent boundary layers, which occur in supersonic flight over a wide altitude range, can cause serious reductions in the resolution of photographs taken through these layers, they asserted.

The authors also described other degrading effects on photography occurring during very-high-speed flight, such as loss of contrast between the ground object and its background by the presence of luminous air in the associated flow field.

• **Survey accuracy cited**—The techniques for achieving super accuracy in surveying the supporting ballistic missile camera sites at Cape Canaveral were described by Commander Glenn W. Moore, U.S. Coast and Geodetic Survey.

The Azusa Model 2 tracking and impact prediction complex there employs several short orientation lines measured to an accuracy of 1 part in 400,000. Since the camera system was partly for use in testing and backup for the Azusa, Moore said, at least equivalent accuracy was mandatory.

However, the USC&GS wrote the requirements for the survey team calling for a precision equal to four times first order, or double the first-order accuracy.

Through a network of quadrilaterals with two diagonals, instead of single triangles, triangulation observations were made on at least each of two nights.

Measurements were performed with a Geodimeter. Combined with spirit leveling and 15 astronomic latitudes and longtitude, by astro-geodetic leveling, the relation between the geoid and spheroid at camera sites were obtained within 2 or 3 feet.

Final results of the survey produced an accuracy of better than 1 part in 1 million, according to Moore.

Use of the Perceptron (that class or family of "intelligent" machines employing the neural net for perceiving and recognizing automata) in experiments relating to photointerpretation was presented by Albert G. Murray of Cornell Aeronautical Laboratory, Inc.

As a result of tests in multiple and single recognition of characters mixed with other simple characters, it is believed that the use of such machines for scanning aerial photos was proved. Much work is needed, but while the lab Perceptron units showed a high rate of false alarm (recognizing unwanted character forms), detection rates for all tests approached 1.0 consistently, Murray said.

It was stressed by the author that Cornell's Mark I Perceptron, used in the tests, was not designed for specific tasks such as photointerpretation. Its sensory apparatus severely limits ground resolution and has no gray scale. Because of this actual aerial photos were not used, but merely approximated.

For the future, the lab will employ machines designed specifically for photointerpretation.

Automatic computation, processing, coordination, etc., in the fields of photogrammetry and cartography were given a fine scanning by Herbert P. Grossman, Concord Control, Inc. He particularly looked at the problem of accuracy vs. cost, indicating that the whole error problem must be faced with a frontal assault.

Yet costs rise staggeringly with each improvement and this fact must be considered by those demanding higher accuracies.

As error sources, he listed random, systematic, dynamic errors as those whereof designers must be fully aware. With study these can be compensated for. However, environmental effects, particularly temperature and humidity, are equally severe in mapping applications.

For these, he said, it is much better to control the environment rather than attempt compensation for changes as they occur.

Finally, Grossman said, if costs are to be heeded and if high accuracy is really the goal in an automatic machine, all other specifications must be relegated to a secondary role.

• **Stereomat pays off**—Winner of the Photogrammetric Award for 1960, donated by Fairchild Camera & Instrument Corp., was Gilbert L. Hobrough. Associated with Hunting Survey Corporation, Ltd., Toronto, Canada, Hobrough was cited for his development of the Stereomat, an automatic stereo plotting system (first reported by M/R, Oct. 24, 1960, p. 20).

The exhibits (over 80) were highlighted by a 3-dimensional model of the SECOR (Sequential Collation of Range). This is the Army Map Service's geodetic satellite program for long-range mapping of the Earth's continents.

Another item drawing wide interest was the Air Force's new Automatic Uniscale Matcher, developed by Autometric Corporation. Essentially a computer, it automatically measures scale distance between centers of PPI radar photos made with the same range setting and containing overlapping terrain detail.

The equipment compares four photos at a time and translates picture data to obtain a coincidence of common information. Output is visual and on punched cards. One complete photomatch requires 30 seconds.

Photogrammetry, Inc., showed its new Zenith Camera System which consists of a Zenith camera and a control unit. Developed for the Air Force, the control unit contains a radio receiver for WWV and WWVH time signals, a dual track tape recorder, batteries, and the camera controls.

The camera is a ground operated instrument designed to obtain photographs of stars at night in the vicinity of the zenith so that subsequent data reduction can be performed to compute the latitude and longitude of the camera station.

This system will allow rapid recording of accurate survey data where requirements, time, or conditions preclude more extensive field survey operations, said P.I.

The control unit is electrically cabled to the camera. Aside from inserting the photographic plate or film and the leveling of the camera, the operation is monitored in total from the control unit. This provides a two-channel tape recording of pertinent time information during exposure of photographic plate.

A continuous signal generated from an oscillator independent of the WWV receiver, provides an accurate record of the shutter opening and closing and the duration of the shutter opening, on one channel of the tape. Concurrent with this, WWV and WWVH time signals are recorded on a second channel for direct correlation with the shutter operation. Two exposures are made on the same plate, 180° out of phase with each other.

Star images can be precisely measured from processed plates in a comparator type instrument. The signals can then be visually read and measured to within 1/50 of an inch for an accurate interpolation, from specially processed magnetic tape.

• **Lorac at AMR**—A feature of an exhibit by Seiscor Division of Seismograph Service Corporation was its Lorac (Long Range Accuracy) system's use at the Atlantic Missile Range.

Employing phase-comparison radiolocation techniques for very accurate distance measurements, the system is installed on tracking and missile-launching ships and on several of the downrange islands.

Used first at AMR in 1952 for position control in a depth-charting survey prior to laying the range telemetering cable (and also during its installation), Lorac was later installed in a network in 1958 to support missile-launching vessels and for missile guidance system evaluation.

For optical and radar tracking shore stations, Lorac-B instrumentation is carried on the launch ships and submarines. Exact position (accuracy better than 1 part in 100,000) of each vessel is transmitted to shore sites for tracking orientation before launchings.

Similar data are provided in the impact areas for computer use to provide acquisition information needed to intercept the trajectory of a warhead and for flight-path evaluation. Position information, Seiscor said, can be transformed readily into true velocity, distance, range, and bearing as needed.

In using the principle of radio signal phase comparison, the Lorac system establishes a gridwork of hyperbolic lines of position. Medium frequency continuous-wave or modulated type transmitters with power capabilities up to 1500 watts are employed. Three or four stations may be used in a Lorac net to perform the trilateration. ⌗

## Servonics Wins Navy Award For Track-While-Scan

THE NAVY has awarded a contract to Servonics, Inc. for an automatic track-while-scan radar system. The TWS system (M/R, Jan. 23) makes it possible to add multiple-target tracking capability to any scanning radar with little modification of existing equipment. Servonics says the development is a significant advancement in radar data collection, processing, and display. *(Ed. note: The Marine Corps is also reported to be contemplating purchase of the TWS for modification of present search radars.)* ⌗

*For limited war . . .*

# Joint Chiefs Map Possible Merger of TAC and STRAC

DEFENSE SECRETARY Robert McNamara has ordered the joint chiefs to prepare a plan which might lead to the merger of the Air Force TAC fighter and air transport fleets and STRAC, Army paratrooper and reserve infantry units.

The move, predicted in COUNTDOWN (M/R, Mar. 27, p. 13), is one of more than 100 analyses of problem areas of U.S. defenses ordered by the new Secretary.

The plan would hand the Army more capability for handling "limited wars," by giving combat forces the control and direction of close air support for ground operations. Pentagon sources predict that the new unit will report directly to the Joint Chiefs of Staff, not Army or Air Force.

TAC has 46,000 officers and men, embracing the 9th Air Force, the 12th Air Force, the 19th Air Force and 10 other air bases in the United States. Its inventory includes fighter-bombers, tactical-reconnaissance aircraft, long-range heavy cargo and assault troop-carrier aircraft, and *Mace* and *Matador* missiles. STRAC has 55,000 officers and men, including the Army's crack paratroop division. Although designed as a four-division combat force, it has been reduced to three by periodic reductions in Army strength.

Some preliminary studies on the merger of TAC and STRAC were conducted by military leaders in the Eisenhower Administration. Gen. Lyman Lemnitzer, then Army chief of staff, worked with Gen. Thomas D. White, Air Force chief of staff, to determine requirement and means for such a merger.

McNamara has given Joint Chiefs Chairman Lemnitzer until May to draft a plan. ⌗

## French Outline Varied Five-year Space Program

### by Jean-Marie Riche

FRANCE has earmarked $2.6 million for a unilateral space program for the next five years.

Besides cooperation in the European space program, France is embarking on its own program to be worked out by the National Center for Study of Telecommunications, Paris University's Research Laboratory of the Atmosphere, Research Center on Cosmic Rays and National Meteorological Department.

The program includes an observation of Venus by astronomer A. Dollfus from a high-altitude (80,000 ft.) point where he will be taken by a "grape" of 30 balloons.

During 1961, the program will include a survey of solar phenomena (cinematographic survey of the Sun spectrography of the solar ring, observation from the Meudon Observatory), the observation of artificial satellites and the calculation of orbits (by 24 stations), research on ionosphere, exosphere, the high and low atmosphere, radio electric research on satellites, experiments conducted with rockets, experiments in the fields of astrophysics using polyethylene balloons and research on cosmic rays.

A number of sounding rockets will be launched in the atmosphere by high-altitude probes, some of them from the Kerguellen islands and new research stations to be established on the South Pole, Central Africa and in France.

In the next five years France will launch *Belier* and *Centaure* rockets from its Saharian base at Hammaguir.

France has also pledged its cooperation to the European Space Research program. ⌗

## Joint Program

### U.S., French Reveal Plans for Launchings

SPACE OFFICIALS of the United States and France have agreed on the first steps in a joint effort in which U.S. rockets and satellites will be used for launching French experiments.

The agreement grew out of joint talks in Washington March 20-21 between officials of the French Committee for Space Research and the National Aeronautics and Space Administration. In a "memorandum of understanding" issued last week, the two groups said there would be these first steps:

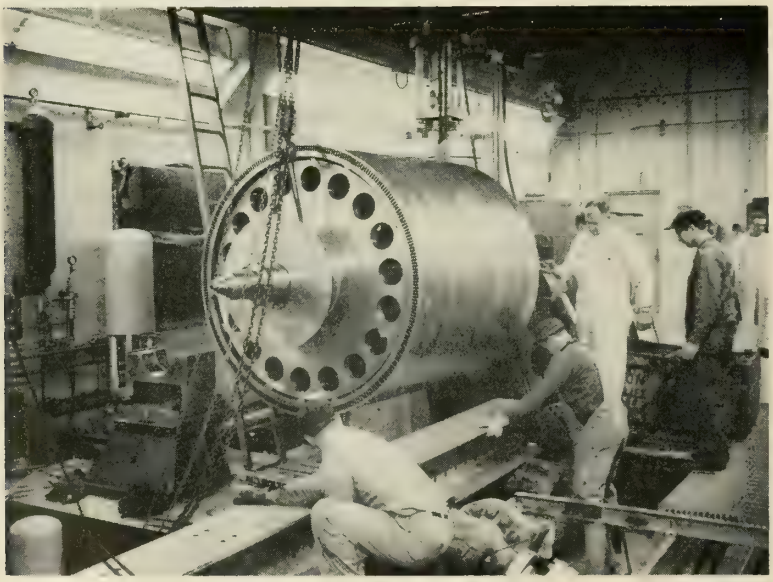
—The French will put together ionospheric, biological and upper-atmospheric experiments for which NASA will provide sounding rockets. The biological experiments would involve no living animals, but spores and molds.

If the results of these shots are satisfactory, the French will prepare similar experiments for incorporation in NASA satellites.

—The French and Americans will cooperate in designing, equipping and operating a launching site for sounding rockets at Quiberon, on the South coast of Brittany, in France.

—NASA will make its training facilities available for French personnel.

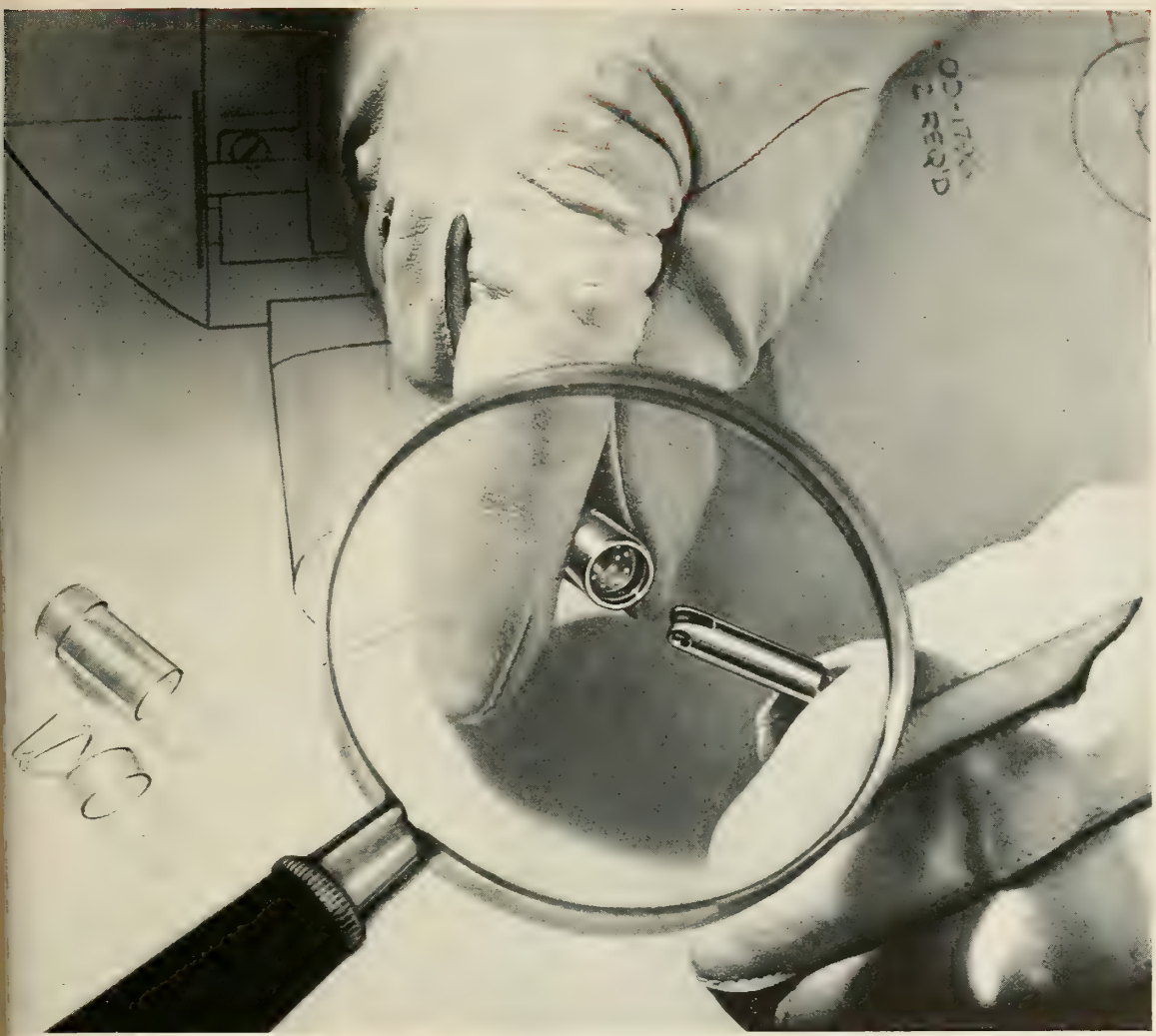
The memorandum made it clear that there would be further cooperation. ⌗



### Heavy Wheeling Tester

*"GATLING GUN" SHOCK TUBE being installed at Cornell Aeronautical Lab will be used for hypersonic testing of aircraft, missiles, and space vehicles. New facility will allow researchers to test vehicles at temperatures of 9000°F and speeds up to Mach 15 for periods as long as 15 seconds. The six-ton, $350,000 rotor is the largest precipitation-hardening stainless-steel forging ever made.*

# NEW DEPARTURES IN MINIATURE



## HOW TO GIVE ON-THE-NOSE GUIDANCE TO MODERN "FISH"

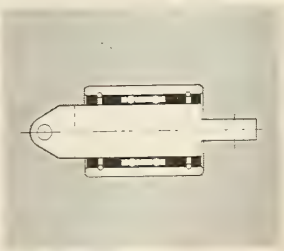
### UNIQUE N/D LINEAR MOTION BEARING FREES GYRO CAGING ACTION

he bearing illustrated is an N/D linear motion precision instrument ball bearing. It was pecially designed and built to help solve a critical problem in the guidance system of a gh speed anti-submarine torpedo.

**ROBLEM:** Loss of accuracy in torpedo's guidance system due to hang-up of caging arm gyro assembly.

**OLUTION:** N/D Sales Engineer, in cooperation with manufacturer, found that *wear* of ushing on caging arm caused hang-up, delaying guidance activation. N/D Engineers t to work to design and build an instrument bearing that operates virtually friction-ee. The result: Preservation of the guidance system's pin-point accuracy and reliability.

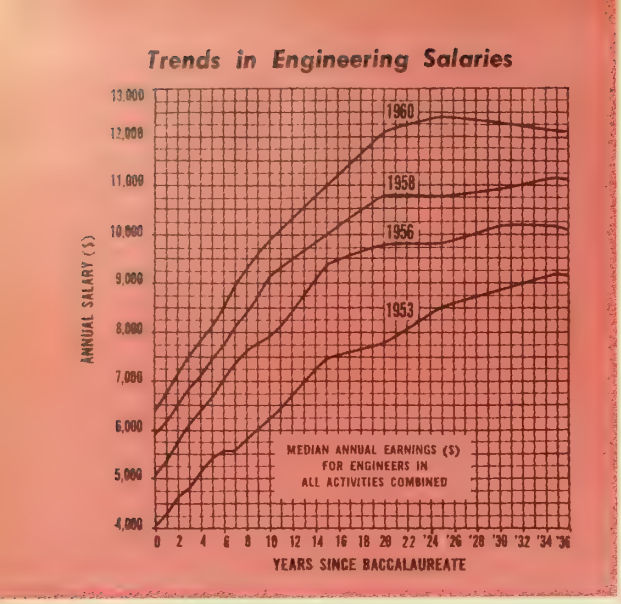
hould you require ball bearing design information, invite the local N/D Sales Engineer to articipate in your early design discussions. He represents one of the industry's largest ngineering staffs devoted exclusively to the design and development of iniature and instrument ball bearings. Or, write for new Miniature and strument Ball Bearing Catalog, Department L.S., New Departure, Division General Motors Corporation, Bristol, Connecticut.



This special N/D linear motion instrument ball bearing increased guidance reliability of ASTOR torpedo weapon system developed by Westinghouse.

**NEW DEPARTURE**
**MINIATURE AND INSTRUMENT BALL BEARINGS**

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# Engineers' Pay Continues to Climb

***Engineering Manpower Commission finds that median salary is 5% more than in 1958, but raises drop after experience***

**by William Beller**

ANNUAL EARNINGS of engineers rose to a median of $9600 last year, an increase of nearly five percent over 1958. Eight years ago, the median was only $6500.

For experienced men, engineering salaries in industry during 1960 were markedly higher than those in Federal government. Surprisingly, the median professional income of an engineer in education was within about $1000 of an engineer with the same experience working in industry.

These figures are part of a statistical survey of the income of engineers conducted by the Engineering Manpower Commission of the Engineers Joint Council. Founded in 1941 and based in New York City, the Council is an organization of many of the leading engineering societies, representing over a quarter of a million engineers.

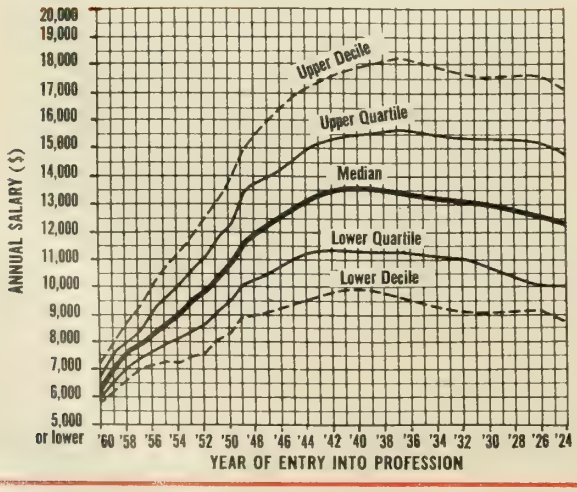
For gathering salary data, this survey was the largest sampling of engineers ever made in the United States. Working chiefly through engineering personnel offices—to avoid possibly biased reports—the Commission salary-checked 185,000 engineers. These included about one-fourth of all engineers employed in industry, and about one-sixth of those in government.

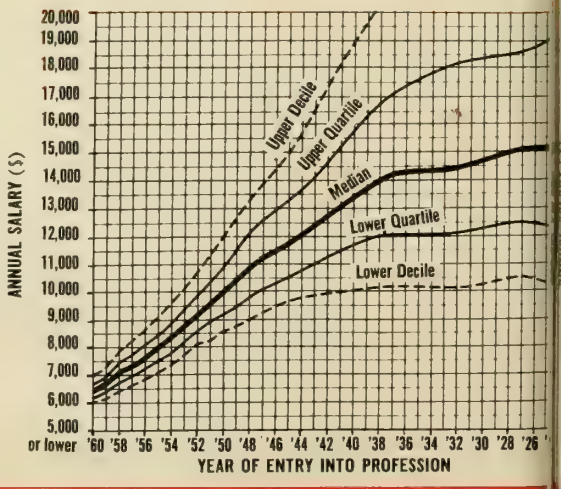
The Commission regretted that a growing number of Federal agencies were refusing to contribute salary data, the response dropping from 42 agencies in 1958 to only 25 in 1960. The Commission also noted "with disappointment" the continued unwillingness of companies in the automotive industry to participate in the survey.

In the seven-year period between 1953 and 1960, while the median year of experience of engineers hovered around 10, the median salary of engineers rose almost 50%. This figure may be compared with a 10% increase in the consumer price index and a 27% increase in the average weekly wages of production workers over the same time period.

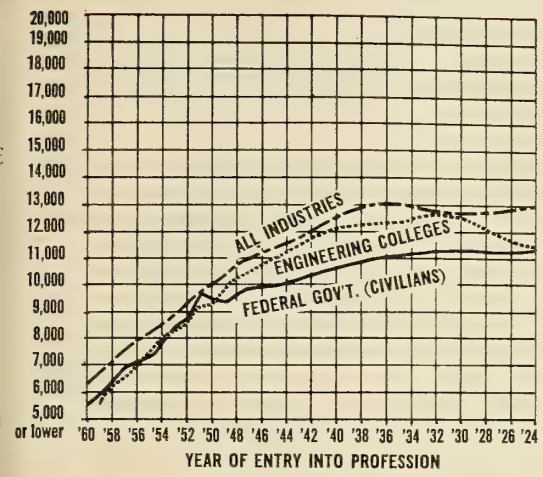
Although the starting salaries of engineers have been rising steadily and substantially—faster that the median salaries—the increases the engineers receive over their first 10 years have been leveling off at about $350 a year.

• **Diminishing returns**—Trends indicate that after an engineer has 10 years' experience, his yearly salary increments tend to become less and less; after 20 years' experience, the engineer wit

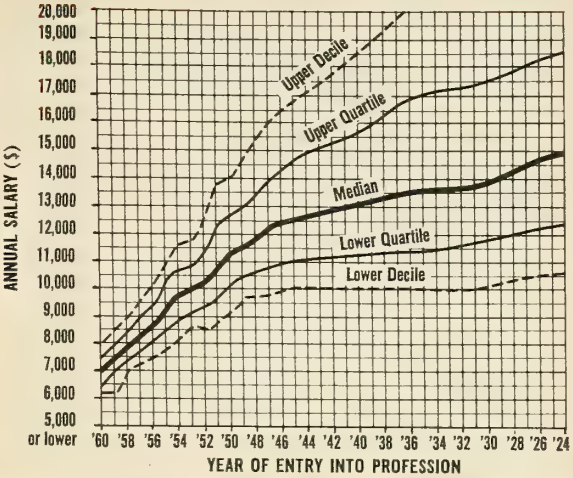


### Median Engineering Salaries




### Research & Development




median salary pattern gets only small nd sporadic raises.

In general, a couple of thousand ollars would more than cover the dif- erence in median salaries paid engi- eers, no matter whom they work for. n their ceiling salaries is where the big ifferences are seen. For example, in ndustry the annual salaries of engineers n the upper decile during 1960 were ll above $24,000. In education, the rofessional incomes of engineers in the pper decile were also high, reaching ver $20,000 a year. On the other hand, overnment engineers in the upper dec- e were barely able to creep beyond the 14,000 mark.

For most engineers in industry, a 14,000 annual salary was the ceiling. n the field of aircraft and parts, the edian engineer in 1960 reached his maximum salary of $13,500 after 20 years' experience, then his pay began slipping. In the other engineering fields, the median salary tended at least to remain constant after reaching a maximum.

• **Degree-conscious**—The statistics indicate that engineers with advanced degrees earn appreciably more than those without them. For instance, the difference between the average salary of an engineer with a doctorate and one with only a master's degree is about $2000. Similarly, the master's degree shows up about $1500 better than the bachelor's.

The top salary of the median engineer with a doctorate was $17,500 a year, which he got after 28 years' experience. The median engineer with a master's got a top of $15,000 after 32 years' experience and the median engineer with a bachelor's got a top of almost $13,000 after 24 years' experience. A similar relationship holds true for engineers in the upper decile.

In this study, the following definitions were used:

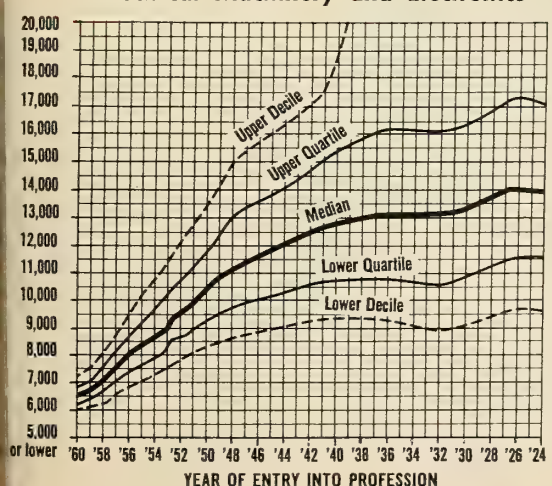
(1) Earnings—Base salary paid by employers including cost of living allowance, if any, and bonus if considered part of salary but not including payments for overtime work.

(2) Professional income—Total annual income from activities related exclusively to the practice of engineering, for the engineer in the field of engineering education.

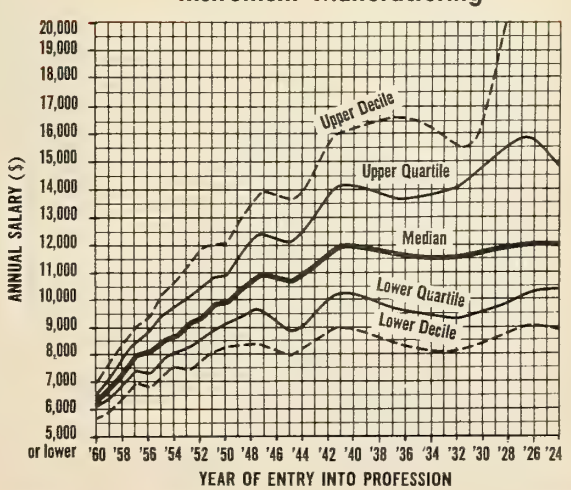
(3) Median—The point in any array of data above and below which half

*(Continued on page 43)*

### Electrical Machinery and Electronics




### Instrument Manufacturing



*An M/R Exclusive*

# Assembled F-1 to be Tested Soon

## *Subassemblies to be joined for first time; emphasis on data collection, analysis will slash PFRT runs*

**by Frank G. McGuire**

CANOGA PARK, CALIF.—Tests of the entire Rocketdyne F-1 liquid-propellant rocket engine assembly this month will begin proving out the design philosophy of the man-rated engine—for which there is still no vehicle. During the tests, to be conducted at Edwards Air Force Base, the injector, thrust chamber, turbopumps and other subassemblies will be combined for the first time. In the past, subassemblies were tested individually.

Initial tests will be carried out at thrust levels slightly over one million lbs. thrust, gradually building up to the maximum 1.5 million lbs. thrust level designed for the engine. Rocketdyne emphasizes the man-rated nature of the F-1's design, which is expected to require only about half the "several hundred" preliminary flight rating tests (PFRT) which were necessary for *Thor* IRBM engines. The F-1 will be ready for flight tests in early 1963.

Principal difference in design of the F-1 is the stress factor increase from the standard 1.2 to at least 1.5 times the maximum expected working pressure or surge. (The 1.5 design stress factor is equivalent to 1.2 times the quantity of 99.5% of the operating envelope plus surge.)

David E. Aldrich, F-1 program manager at Rocketdyne, says the F-1 and the *Saturn* H-1 engines are similar in concept except for the start energy source used. Whereas the H-1 uses solid propellant gas generator to start the operating sequence, the F-1 utilizes initial tank head to fire the gas generator and start the turbopumps.

Liquid oxygen valves open first, followed by fuel, in a pressure ladder sequence using interlocking valves. One failure in the system will shut everything else down. A hypergolic ignition system is used for the main chamber, and spark ignition for the gas generator. Triethylboron is sometimes used, but triethylaluminum is more nearly standard.

• **Reliability first**—According to Rocketdyne, the biggest problem with man-rating the reliability of the F-1 is its sheer size. Internal stresses on materials dictate a meticulous design review at every stage—a review much more formal than those in preceding programs.

In the words of Rocketdyne's Dr. Charles Davenport: "We all realize there will be a man riding on this thing."

Weight penalties for an extra pound of structural beef in the F-1 are not as severe as on other engines, and the extra beef is preferred for the reliability it provides. Nevertheless, there is no place for great generosity in the allocation of weight, even though the National Aeronautics and Space Administration encourages the beefed-up, reliable approach.

Reliability comes first . . . performance second.

In the sequencing of the engine, various functions must be performed or a shutdown will occur. The pressure ladder approach insures that proper sequencing is followed by the engine's fluid-handling system; ignition is used as a final veto power.

Dominick J. Sanchini, F-1 assistant program engineer, points out that ignition-detection wires must be burned through before valves can open to admit fuel and LOX to the combustion chamber. No ignition, no propellants.

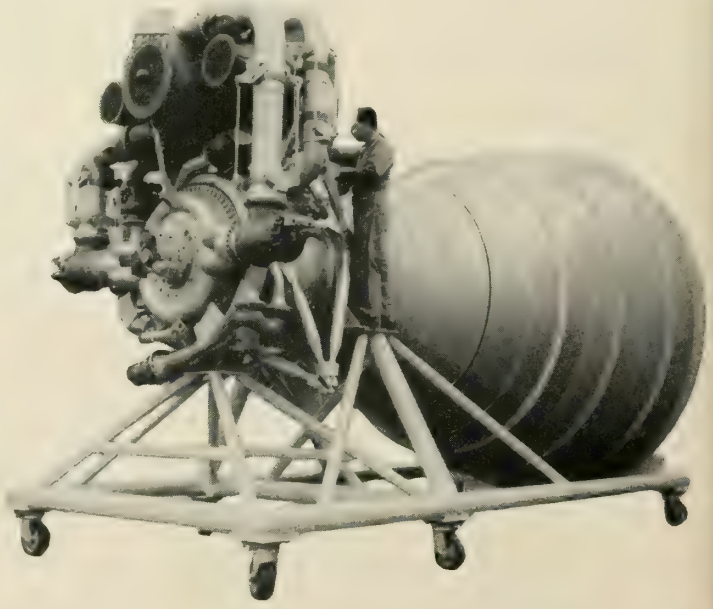
In a multi-engined vehicle such as that often envisioned for the projected *Nova* booster, failure of ignition in one of several chambers doesn't appear to pose much of a danger, Rocketdyne says. *Atlas* and *Saturn* clustered boosters have not encountered this problem, the company says, and a large booster is also unlikely to run into any great troubles with it.

• **Data emphasized**—To back up its reliability requirement for the F-1, Rocketdyne is building a statistical test design unit for advance design of experiments, thus calling for "pre-thinking" of all phases of the system.

Digital data via the Rocketdyne Automatic processing of Integrated Data (RAPID) is simultaneously handled on an IBM 7090 computer. Much more data is obtained through serialized component analysis.

The immediate effect of the great emphasis on data collection and analysis will be the anticipated reduction in the number of runs required for PFRT. Another benefit will be the tightening of procedural control, tolerances and overall quality control.

Tolerances currently used in fabrication of the F-1 are on the machine-



*ENGINEER INSPECTS full-scale mockup of the huge Rocketdyne F-1 engine.*

ool level, rather than the aircraft level, nd are hovering about the 0.003 in. to .004 in. mark for the thrust chamber, nd much tighter on valves and similar omponents.

Reliability through simplification is chieved with such techniques as a irect-drive turbopump using no gear-ox at all. The turbopump speed, inci-lentally, is 6000 rpm, with a fuel flow pproximating 2% of the main engine low—estimated at two tons of LOX nd one ton of narrow-cut kerosene RP-1) per second.

The 15,000-lb.-gross-weight engine as its turbopump mounted directly on he thrust chamber for simplicity and ompactness. All other components are nounted on one of these two subsys-ems or on the plumbing between them.

In gimballing, the high-pressure ucting is not flexed. Instead, the entire ngine is gimballed, using the fuel as high-pressure hydraulic actuating nedium.

• **Little wiring**—Only two com-onents in the engine use electrical viring or energy—the four-way sole-oid valve and the spark igniter for as-generator ignition. Fuel, oxidizer nd gas-generator valves use fuel as heir actuator hydraulic medium. To liminate the turning movement of but-erfly or ball valves, the fuel and LOX alves in the F-1 are the poppet type, which simplifies sealing problems and ninimizes package size.

Duration of the tests to be con-ucted at Edwards will be shortened rom expected operational levels due to limitation on propellant capacity at he test facilities. Huge, high-pressure tanks of stainless steel with five-in.-thick walls can hold up to 20 seconds of propellant for the F-1. Control valves for these tanks weigh six tons.

Thrust chambers will be mounted in a position 30 degrees below horizontal, to eliminate the need for a flame deflector. Several engines can be tested on the same stand to check out clustering techniques, and a capability for testing clusters up to 12 million lbs. thrust is in reserve. Rocketdyne has done virtually no testing of the F-1 under a million lbs. thrust.

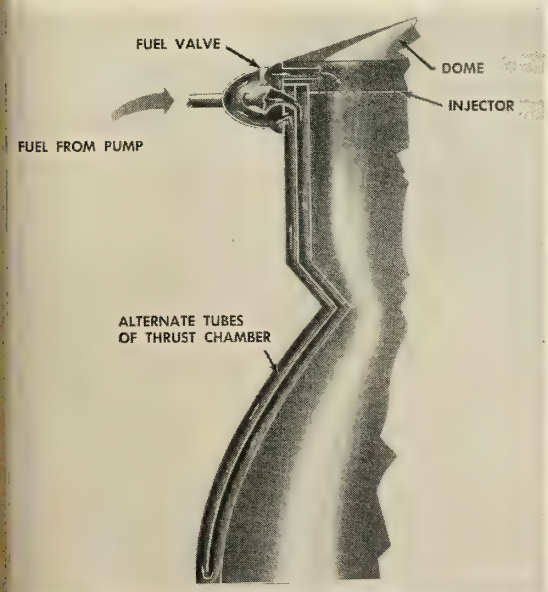
• **Three blocks**—Upon completion of its PFRT, the F-1 will have gone through three design blocks. The first is that based on purely theoretical calculations, the second will be a major cleanup of deficiencies found in the first block, and the third block will be a polished product ready for flight tests.

For the first block, Rocketdyne had the advantage of using existing hardware left over from an Air Force contract for a megapound-thrust rocket engine. This contract, going back to 1955, provided Rocketdyne with some injector hardware for conducting the first three firings in the F-1 program for NASA.

Rocketdyne's first rocket engine firing at one million lbs. thrust was carried out in early 1959, using Air Force hardware, and demonstrated stable combustion.

The F-1 is slated to undergo its preliminary flight rating tests in late 1962, completing the series in early 1963 with 18,000 seconds of development testing to its credit. First tests, beginning this month, will stress the start and shutdown sequences in short-duration runs. Then will follow checkout of performance, durability, reliability, and repeatability factors.

As an estimate of what a clustered F-1 vehicle could do, Rocketdyne assumes a typical application in a six-engine booster with 9,000,000-lbs. thrust. Such a booster would put 400,000 lbs. into a low earth orbit, possibly for space assembly of a large vehicle for interplanetary missions. Other payload capabilities would depend on upper staging, types of upper-stage engines, and similar variables. ⌘

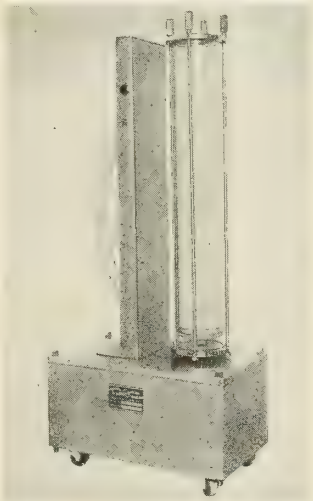



*CROSS-SECTION OF BELL of the F-1.*





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# Redstone Wins Okay for Mercury

## *Escape system and landing bag still face tests; shot of manned capsule may come late this month*

AMERICA'S PROJECT *Mercury* —in an apparent losing race to launch the first man into space—has given a stamp of approval to the *Redstone* booster.

Two final spacecraft qualifications, the capsule escape system and a landing bag to reduce the effect of impact with the water, remain before a manned flight can be scheduled with *Mercury Redstone 3*.

Present indications are that it might be possible to launch a man by the last week of April. However, Russia may well have orbited a man by then. Presumably, Soviet authorities are going through an agonizing decision this week on whether their capsule is ready for manned flight with a record of three successes in five attempts.

The U.S. *Mercury* program gave final approval to the *Redstone* after a March 24 flight in which it plunged into the Atlantic Ocean with a boilerplate capsule a half-mile from the target, 311 miles down the Atlantic Missile Range from Cape Canaveral.

The *Redstone* ballistic development flight carried the rocket to an altitude of 115 statute miles. Neither capsule separation nor recovery was planned. Maximum acceleration during the flight was 6½ g.

Final qualification work with the capsule landing bag is under way in a series of parachute drop tests in the Atlantic off the Virginia coast. An Air Force cargo plane has been dropping the recovered *MR-2* capsule from altitudes of 30,000 to 35,000 ft. off Hampton Roads. The tests, which began about two weeks ago, are expected to continue another week or so.

The landing bag, which broke off in impact with the sea on its first test with *MR-2* Jan. 31, worked properly on the *Little Joe 6* flight March 18. However, that flight did not provide a thorough qualification test for the bag because both the main and reserve parachutes opened at altitude, slowing descent much more than normal.

• **Little Joe premature**—Thorough analysis of telemetry data from the *Little Joe 6* flight at Wallops Island, Va., showed it fired prematurely instead of late, as reported last week (M/R, March 27, p. 61). A signal by ground command later accomplished capsule separation.



*PROOF OF Redstone booster's fitness was this successful firing on March 24.*

The *Little Joe* capsule was flown back to the McDonnell plant in St. Louis for fitting with new retro and escape packages for another flight aboard a new *Little Joe*. McDonnell is expected to return the capsule in a week or so.

Since the new *Little Joe* flight is likely to take place in a few weeks, NASA officials have decided to hold up the manned *Redstone* flight until after both *Little Joe* and completion of the drop tests.

Meanwhile, The Martin Co. announced it is obtaining the services of more than 30 companies to aid in its studies of Project *Apollo*, the NAS post-*Mercury* manned spacecraft, fr of charge.

Martin, Convair and General Ele tric are conducting parallel six-mon *Apollo* studies for NASA under si month cost-sharing $250,000 contrac due for completion May 15. Mart listed these companies as among tho from which it is obtaining services:

Propulsion — Aerojet-General, Be Aerosystems, Grand Central Rocke Marquardt, Pratt & Whitney, Rocke dyne, Thiokol and United Technolog Guidance — American Bosch Arm Autonetics, Raytheon and Sperr Phoenix. Recovery — Cook Researc Goodyear Aircraft, Kaman Aircraf Radioplane and Thiokol. Tracking telemetry—AiResearch, Bendix, Ele tro-Mechanical Research, Epsco, RC and Tele-Dynamics. Environmental co trol—AMF, Hamilton Standard, Hot man Electronics, International Rectifie Sundstrand Turbo, Thompson Ram Wooldridge and Westinghouse.

## NASA Set to Ask Bids For Ion Engine Vehicle

MARSHALL SPACE Flight Cent is expected to seek industry bids soo on a spacecraft to house the Hughes ic engine on its first flight test in Octobe 1962.

A *Scout* vehicle will launch the 20 lb. package containing one or two .00 lb.-thrust Hughes engines on a traje tory that will carry it above 250 naut cal miles altitude for at least 50 mi Well over half the weight will be ba teries and a dynamotor to provide 1 k at 5-10 kv for an hour.

The purpose of the test is to pro that beam neutralization works in spac and that the engine actually generat thrust. The test will measure whatev thrust is produced.

NASA added $321,000 to an earli $490,000 Hughes contract to contin the work until more money is availab from Fiscal Year 1962 funds. Ult mately, NASA plans to power ion an plasma engines with the *SNAP 8* n clear powerplant, which will be avai able for flight test about 1965.

*Centaur* will probably be the launc vehicle for *SNAP 8*-powered orbit flights, which will carry both plasm and ion engines. Operational use ma be possible by 1966 or 1967.

## industry

**THIOKOL CHEMICAL** Corporaons earnings for FY 1960 fell 35% ower than 1959 earnings. Net sales ropped 10%, or $19 million.

The company said that in its misle activities, changing military requirements, combined with long delays in me between the submission of proposals nd contract awards, affected volume nd profits. "In addition," the annual eports said, "costs in excess of original stimate under certain costs-plus-fixedee type contracts were incurred."

A Nuclear Development Center was stablished by the company during the ear and is teaming with several other rms in proposals pending to National eronautics and Space Administration nd the Atomic Energy Commision.

Thiokol's sales for 1960 totaled 171.5 million, compared with $190.2 illion. Net income last year was $3.56 illion, off from $5.52 million the preious year.

**UNION CARBIDE METALS CO.** as established a Refractory Metals Dept. to produce and sell space-age etals such as columbium, tantalum, anadium and tungsten. D. H. Barbour as been appointed general manager of ne department. The company also has reated a New Products Sales group, hich will be under the direction of F. I. Buttner.

**CHANCE VOUGHT CORP.** has igned an agreement to acquire Harbor oat Building Co. and Harco Engineerng Co., both of Los Angeles. The ompany said the move was made to xpand its antisubmarine warfare and arine engineering programs, and proide a salt water access to augment acvities in oceanography, ship's instrunentation and other marine equipment.

**DUPONT COMPANY** started up s Belle, W. Va., plant, which will make ethylamines and their derivatives, inluding DMAC, which it reduced in rice by 30%. It also will produce MA, a gas used in the manufacture of issile fuels.

**ELECTROMAGNETIC TECHOLOGY CORP.,** established at the tanford Industrial Park, has been ormed as a research, engineering and evelopment organization. The comany has technical interests in microave antennas, components and sysems, instrumentation, thermoelectric nergy conversion, electromagnetic enironmental control and application of icrowave technology to various procssing and control operations.

## Vehicle Windows

*(Continued from page 23)*

ent upon several major factors, among them the environmental conditions and duty cycles of the specific application, the variations of material strength with temperature, the modulus of elasticity available at high temperatures, variations in the coefficient of thermal expansion, oxidization resistance and metallurgical stability at high temperatures.

The common sealing alloys such as Kovar, Therlo and Rodar are well suited to 1723 glass in the 0°-800°F range. But these alloys have such low yield strengths at temperatures that their use would have to be restricted to the function of an intermediate material, imparting a gradient expansion between the glazing and the high-expansion structural framing material.

Corning regards this gradient expansion design with interest, because of the position the Kovar type materials and the titanium family occupy between glazing and structural metallic expansion values in the 1000°-1600°F range. But the addition of an intermediate material in a framing design will require another sliding seal in the installation besides the one cushioning the glazing.

Molydenum alloys and some of the columbium family also exhibit low thermal expansion characteristics in the 0°-2400°F range. Corning believes that these alloys, combining high strength with low thermal expansion coefficients, will ultimately prove to be the ideal framing material for glazings. ⁂

## Engineer Salaries

*(Continued from page 39)*

of the series is located, that is, the midpoint.

(4) Upper decile—The point in any array of data above which 0.1 of the series is located and below which 0.9 of the series is located.

(5) Engineers—Those holding a minimum of a bachelor of science degree in a recognized field of specialization in engineering.

(6) Year of entry into the profession—The year in which the engineering baccalaureate degree was awarded.

If the present trends are projected, the next biennial study probably will show the median engineer with no experience starting at between $6500 and $7000 a year. Ten years later he probably will be getting an annual salary somewhat more than $10,000. He can expect to get a maximum salary of about $14,000 after 20 years' experience. ⁂


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*Send resume in confidence to Mr. H. C. Horsley, Personnel Mgr.*

**Requirements**

General ordnance engineering; emphasis on propellants, ballistics, thermodynamics, hydraulics, mechanical design; responsible project engineering experience including preparation of proposals, costs, schedules and technical reports. Also seeking specialist with knowledge of exploding bridge-wire systems and devices, electro-explosive theory, and detonation wave theory.

**HOLLISTER:** convenient to San Francisco, Carmel, Monterey.




Circle No. 10 on Subscriber Service Card

# contracts

## NASA

$97,631—**Beckman Instruments, Inc.**, Anaheim, Calif., from Marshall Space Flight Center, Huntsville, Ala., for design, development and fabrication of computing equipment for reduction of Doppler tracking data.

$96,411—**Dynametrics Corp.**, Burlington, Mass., for design, development, fabrication and check-out of automatic calibration system for pressure transducers.

**Wyle Laboratories**, El Segundo, Calif., from Marshall Space Flight Center for R&D on evaluation of a high-accuracy mass flowmeter for use with liquid hydrogen. Amount not disclosed.

## NAVY

$3,000,000—**Huyck Systems Corp.**, Huntington, L.I., N.Y., for tactical antisubmarine warfare computer and display system.

$445,000—**Electro-Tec Corp.**, South Hackensack, N.J., for slip ring assemblies for the *Tartar* missile program. Subcontract from **The Raytheon Company.**

$250,000—**Olin Mathieson Chemical Corporation's Research Center**, New Haven, Conn., for basic research studies in boron chemistry for ONR.

$171,000—**Gladding, McBean & Co.**, Los Angeles, for further production of ceramic radomes for the *Sparrow III*. Subcontract from **The Raytheon Co.**

## ARMY

$23,200,000—**Western Electric Co.**, New York, and **Douglas Aircraft**, Charlotte, N.C., for production of *Nike-Hercules* missiles.

$4,029,019—**Western Electric Co.**, Burlington, N.C., for production engineering services for the *Nike-Hercules* air defense missile system.

$584,574—**The Raytheon Co.**, Waltham, Mass., for concurrent repair parts and retrofit kits for the *Hawk* missile system. Two contracts.

$500,000—**Hughes Aircraft Co.**, Culver City, Calif., for continued development of an advanced guidance unit for the *Mauler* air defense system. Subcontract from **Convair/Pomona Division of General Dynamics.**

$476,545—**The Raytheon Co.**, Waltham, Mass., for retrofit kits DA-19-020-ORD-5157.

$370,204—**Radioplane Division of Northrop Corp.**, Van Nuys, Calif., for drone system AN/USD-1A. Two contracts.

$245,700—**Microwave Associates, Inc.**, Burlington, Mass., for electron tube, Type 6229.

$208,874—**Sperry Rand Corp.**, Salt Lake City, for publications, ground handling and test equipment for the *Sergeant* guided missile system. Four contracts.

$99,168—**The Martin Co.**, Orlando, Fla., for repair parts and/or modification kits for *Lacrosse* systems.

## AIR FORCE

$2,200,000—**General Electric's Light Military Electronics Department**, Utica, N.Y., for airborne transponder for use in the *Mistram* missile trajectory measurement system.

$935,000—**The Marquardt Corp.**, Van Nuys, Calif., for continuing production of inlet controls systems, components, and spare parts for the *Hound Dog* missile. Subcontract from **Space and Information Systems Division of North American Aviation, Inc.**

$905,358—**Sperry Rand Corp., Sperry Gyroscope Division**, Great Neck, N.Y., for components of radar set AN/APN-59B, spare parts, ground support equipment and data.

$515,107—**Philco Research Division**, Philadelphia, for investigation of novel components as applied to a high-resolution radar antenna. Subcontract from **Rome Air Development Center.**

$285,000—**Hill Electronics, Inc.**, Mechanicsburg, Pa., for development of a precision oscillator for the radio launch control system of the *Minuteman* missile, Subcontract from **Electronics System Division of Sylvania Electric Products, Inc.**, Buffalo.

$280,000—**Electro-Tec Corp.**, South Hackensack, N.J., for components used in AN/FPS-26 height-finding radar antenna. Subcontract from the **Electronics and Ordnance Division of Avco Corp.**

$196,374—**Kearfott Division, General Precision, Inc.**, Little Falls, N.J., follow-on from Wright Air Development Division for gas-bearing gyros.

$192,000—**Defense Electronics Products Division of RCA**, Moorestown, N.J., for nonpersonal technical services for on-site scheduled overhaul and emergency technical assistance and supply support of two each AN/FPS-16 instrumentation radars of the Atlantic Missile Range.

$160,000—**Sylvania's Reconnaissance Systems Laboratory**, Mountain View, Calif., for development of anti-intrusion equipment; specialized alarm system designed to protect restricted areas from unauthorized entry. From Rome Air Materiel Area, Griffis AFB.

$112,000—**The Electronics Division of Chance Vought Corp.**, Dallas, for production of actuator housings for the *Titan* ICBM. Subcontract from **The Martin Co.**, Denver.

$94,000—**Electro Nuclear Systems Corp.**, Minneapolis, for development of advanced data processing techniques to be used in a classified military porgram.

$94,000—**The Unitec Corp.**, Baltimore, for emergency depot level reconditioning of eight each rigid radomes.

$91,972—**Lockheed's Missile and Space Division**, Sunnyvale, Calif., to design and fabricate spectrometers for the measurement of high-energy protons in the Van Allen Belt.

$90,738—**General Electric's Missile and Space Vehicle Department**, Philadelphia, for regenerative fuel cell for space power use and technical personnel for checking its operation under weightless conditions during planned jet aircraft flights.

$85,000—**Northeastern University**, Boston, for theoretical and experimental research on Statistical Communication Theory.

$55,018—**Lockheed Aircraft Corp.**, Burbank, Calif., for investigation of effect of communications and navigation satellites upon EMS concept and design.

$30,000—**Grand Central Rocket Co.**, Redlands, Calif., for design criteria, specifications and consultation relative to conversion of portions of the plant to a facility capable of manufacturing propellants and loading, assemblying, packing and testing propellant rocket motors, components and accessories.

$26,857—**California Computer Products**, Downey, for control logic and system design for vehicle system.

$26,082—**Dynatronics, Inc.**, Orlando, Fla., for airborne telemetry test and calibration systems.

**Space Technology Laboratories, Inc.**, Los Angeles, for detailed systems engineering and technical direction for those *Atlas* and *Titan* ICBM boosters to be used in support of the *Nike-Zeus* program. Amount not disclosed.

# reviews

**METALS HANDBOOK, 8th Edition, Vol. 1 PROPERTIES AND SELECTION OF METAL** American Society for Metals, Novelty, Oh 1300 pp., $30.

The ASM Metals Handbook eighth e tion is devoted exclusively to the selecti and properties of metals. It is the first a projected series of volumes which wi when completed, cover all branches metals engineering and metalworking.

A new section provides coverage stainless steels (both cast and wrought including the more recently develop precipitation-hardening alloys.

Separate sections are devoted to alun num, magnesium, iron-base super-streng alloys, nickel-base and cobalt-base allo and titanium and titanium alloys. Includ in a section on carbon and low-alloy stee are a number of special articles deali with selection for maximum yield strengt hardenability, fatigue resistance, not toughness, wear resistance, and resistan to corrosion.

The book has a completely cros referenced 64-page index.

**OXIDATION BEHAVIOR AND PROTECTI COATINGS FOR COLUMBIUM AND COLU BIUM-BASE ALLOYS**, W. D. Klopp. Order PB 1 080 from Office of Technical Services, U.S. De of Commerce, Washington 25, D.C. 97 pp., $2.2

The report summarizes and discuss the information available to Dec. 19 on the oxidation behavior of columbiu and columbium-base alloys.

The data are presented in three se tions. Under oxidation behavior of colu bium are discussed the columbium-oxyg system, and the reaction of columbiu with oxygen, air, or nitrogen.

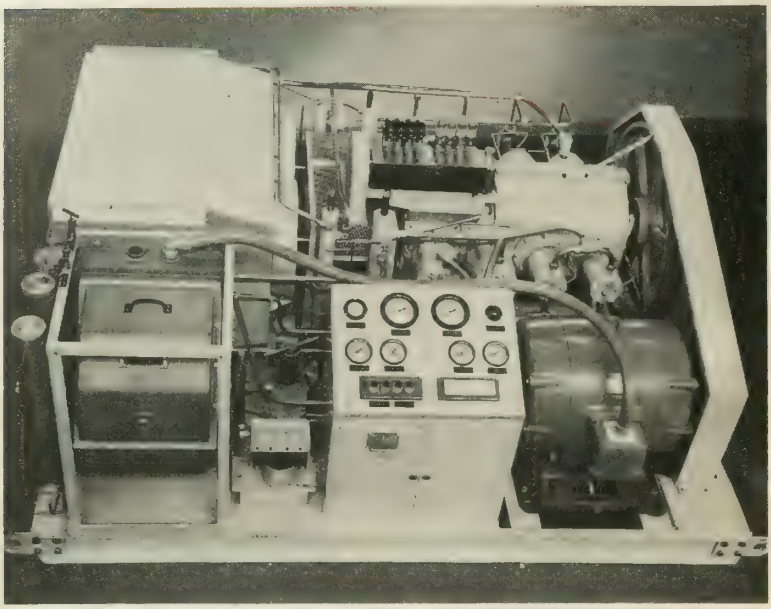
In the section devoted to alloys, ox dation behavior data are given for binary columbium alloys and seven terna and more complex columbium alloys. Th section on protective coatings for colu bium includes a discussion of coating r quirements, types of coatings and metho of application. Also included in this se tion is a summary of test results on th efficacy of various types of coatings, givi evaluations of electroplated, vapor-an pack-deposited, clad, sprayed, and liqui phase diffused coatings, as well as a evaluation of undefined coating processe

**PROPERTIES OF REFRACTORY MATERIALS: CO LECTED DATA AND REFERENCES**, W. G. Bra shaw and C. O. Matthews, Lockheed Aircraft f U.S. Govt. Order PB 171 101 from Office of Tec nical Services, U.S. Dept. of Commerce, Was ington 25, D.C., 110 pp., $2.50.

A comprehensive survey of the prope ties of refractory materials with meltin points above 2500°F was made to assi in the selection of materials which sho promise for use in high-temperature mi sile and nuclear applications.

The physical, mechanical, and chem cal characteristic of these materials elevated temperatures are presented i tabular form.


Research
And
Engineering
For
MAN IN SPACE
M/R's special issue covering the research and engineering phase of Man in Space is extremely important and timely... will be read and re-read by M/R's space-oriented audience of over 31,555* paid subscribers.
*Subject to audit.
MISSILES AND ROCKETS
MAY 29, 1961
CLOSING DATE MAY 8
Materials
Boosters
Electronics
Space Medicine
Re-entry



## High-Capacity Compression System

A central compression system specially designed to meet the increasing need for relatively high-capacity, short-time or continuous delivery of maximum-purity air, helium, nitrogen or other gases is available from Cardair, Division of Marmon-Herrington Co., Inc.

The systems, known as DPB-CCS, guarantee supply of gas at discharge pressure of 3500 to 12,000 psi continuous, with less than 1 ppm oil content and dewpoint of −100°F. Capacity is 150 scfm at 128 psig intake, utilizing a 4-stage, 8 cylinder compressor as standard. The complete system includes dehydration and oil removal equipment and control panel. Maintenance is said to be minimal and simple, with nationwide service facilities available.

Circle No. 225 on Subscriber Service Card

## Compact ADC

An analog-to-digital converter with a conversion rate of 0.5 microseconds and measuring only 6½ x 3½ x 6¼ in., is available from the General Data Corp.

The solid-state ADC, General Data Model 101, requires only a single decision per conversion, instead of the usual successive approximation technique.

Input voltage range of the unit is 10 volts at an impedance of 250 ohms. An optional input impedance of 100,000 ohms is also available. Accuracy is ±.5%, ±½ least significant digit.

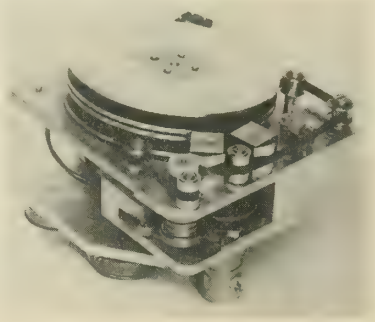
Circle No. 226 on Subscriber Service Card

## Satellite Recorder

A miniature magnetic tape recorder/reproducer for satellite and missile application, capable of operating on 1/20 of the power previously considered practical, has been developed by the Datalab Division of Consolidated Electrodynamics Corp.

Power consumption is rated considerably less than one watt, and size is expected to approximate 100 $^3$ in. when the design configuration is finalized. It has an estimated life of at least 4000 hours, operates at a reproduce-to-record speed ratio of 18:1 (ratios up to 100:1 are feasible), and weighs less than six lbs.

Circle No. 227 on Subscriber Service Card



## Printed Circuit Relay

A high-reliability microminiature relay designed especially for printed-circuit applications is available from Control Dynamics Corp.

The relay—named the Centipede—has a height of only 0.44 in., making it ideal for military and commercial applications where vertical space is limited. The relay's eight terminals and four mounting pins fit on 0.200-in. centers for standard printed circuit grid mountings.

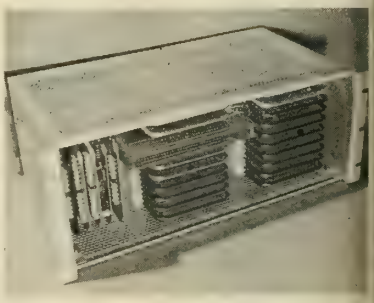
Circle No. 228 on Subscriber Service Card

## Instruction Memories

High-speed BIAX magnetic core instruction memories in several standard sizes are available from Aeronutronic Division of Ford Motor Co.

The memories operate at one megacycle, with an access time of 0.4 microsecond, using non-destructive readout BIAX memory elements. Two standard sizes are presently available—128 words and 512 words, with 24 bits per word. Other sizes up to 1024 words and 36 bits per word can be built on a fixed-price basis to customer specifications.

No rewrite circuitry is needed for



the non-destructive BIAX memory, and loading equipment, also available from Aeronutronic, is detachable. Loading can be performed at speeds up to 200 kc if desired, but the standard input is from punched paper tape.

Circle No. 229 on Subscriber Service Card

## Metallic Static Face-Seal

Haskel Engineering & Supply Co. is marketing a line of metallic static face-seals designed and manufactured specifically to meet the high pressure and extreme temperature requirements of systems in missiles and high-performance aircraft.

The HS Series Seal can be utilized to provide zero leakage at a wide range of temperatures from −450° to 2000°F and pressures to 20,000 psi.

The seals are lapped to provide flat-

ess and smoothness of the sealing aces. A flat surface with a finish of 2 RMS or better is adequate to pro-ide a mating surface. The seals incor-orate an integral spacer which avoids ne problem of controlling groove depth losely. Installation is accomplished by nerely indexing the seal to one mating rface and bringing the opposing sur-ace against the seal.

Circle No. 230 on Subscriber Service Card

## Magnetic Drum Check-out

FMA, Inc. has developed test equip-ent for recording timing tracks and roviding general check-out of a mag-etic drum system.

Known as the Model MD-100 Mag-etic Drum Check-Out System, it offers lock recording, clock smoothing, origin nd word track recording and test pat-rn recording.

A clock track may be recorded ircumferentially around the drum with pre-selected number of bits, up to 6883. Closure on this timing track ay be made better than 50 millimi-roseconds. The system is capable of ecording in either the non-return-to-ero (NRZ) or in the Manchester ethod.

Circle No. 231 on Subscriber Service Card

## Metal Film Mylar

Filmohm Corp. is showing a thin nd completely flexible microwave ab-rbing material. The resistance material a thin film of pure metals, approxi-ately 50 millionths of an inch thick, niformly deposited on the surface of ne Mylar. Any value between 25 nd 400 ohms/square can be supplied, lerance is ±10%. Standard values re 50, 100, 150, 200, 300 and 377 hms/square. Silver contact areas can e provided for DC contact. These ust be applied before deposition of ne resistance film. DC contact cannot e made to the film in any other way. ominal resistivity in ohms/square, ickness, and date of manufacture is amped on the back of each sheet.

Circle No. 232 on Subscriber Service Card

## ulse Generators

A line of pulse generating equip-ent featuring high repetition rates and st rise and fall times is available from exas Instruments Inc.

The line includes two clock pulse enerators and a programed pulse gen-rator. Extremely fast rise and fall time ulses are achieved through the unique esign of the equipment's solid-state rcuitry.

The Clock Pulse Generators include 3-25 mc unit and a 25-100 mc unit ith appropriate overlap to provide ntinuous pulse sources from 3-100 c. Provision has been made in the



design to allow for external drive input to provide repetition rates below 3 mc and to permit the operation of several Clock Pulse Generators controlled by a master source.

Circle No. 233 on Subscriber Service Card

## Semiconductor Test Equipment

Molecular Electronics, Inc., is introducing four types of semiconductor-device test equipment.

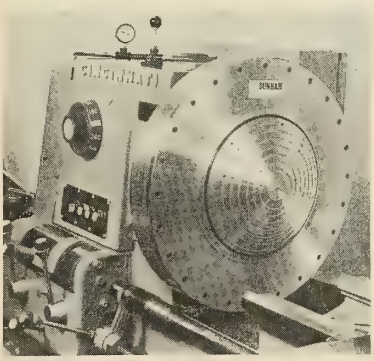
The semiconductor-device test equipment includes 1) an in-circuit test set, 2) a general-purpose tester, 3) an alpha-cutoff test set and 4) a gain-bandwidth tester.

A general-purpose test set also will be displayed, which can measure AC and DC parameters for both diodes and transistors. Leakage currents down to 1.5 microamps (full scale) also can be detected with the new unit.

Circle No. 234 on Subscriber Service Card

## Vacuum Chucking System

Dunham Tool Co., Inc. is marketing a missile vacuum-checking system for holding missile and aircraft components such as ceramic nose cones and stainless parts up to 100 in. in diameter. Activated by a vacuum pump with hold-down pressure of 12 psi,



chuck develops over 33,000 lbs. of distortion-free, hold-down pressure on a 60 in. diameter part. An automatic safety device is incorporated to prevent loss of vacuum in case of power failure.

Special designs permit boring I.D., facing and turning O.D. concentric within 0.001 in. on parts up to 100 in. in diameter. Also, forgings and sand castings can be chucked with equal facility.

Circle No. 235 on Subscriber Service Card

## Missile Diagnostician

An automatic electronic analyzer that will predict the operational readiness of an intercontinental ballistic missile, or any other complex weapon system, is available from Hughes Aircraft Co.

The machine is called D-PAT, short for "drum-programed automatic tester." Using a digital computer with test-program procedures stores on a magnetic memory drum, D-PAT detects and isolates malfunctions in any system down to the smallest replaceable unit or assembly.

With its memory drum whirring at 2300 revolutions a minute, D-PAT electronically clicks through a system checklist, confirming its own measurements with known values stored on the drum, and automatically starts exploring to investigate a suspected trouble spot.

Circle No. 236 on Subscriber Service Card

## Telemetry Decommutator

An "off-the-shelf" PCM telemetry decommutation unit is available from Electro-Mechanical Research, Inc. The decommutation unit is expected to make digital telemetry a practical reality for all telemetry users.

The versatility of the system permits its use as a universal ground station, since it accepts any time-multiplex signal, whether PAM, PDM or PCM, and provides both analog and digital outputs.

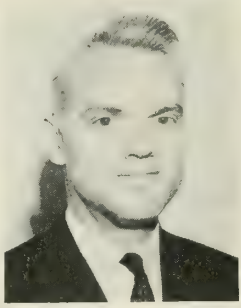
Designated the Model 185 Digital Decommutation Unit, the equipment can be set up to accept these signals by setting a single knob. The standard decommutator accepts a wide variety of word and frame formats, including all IRIG-specified formats, at bit rates up to 80 kc. Between 10 and 128 channels or words per frame can be handled. PCM inputs can be parallel or serial binary in RZ, NRZ, or NRZI. Words may be any length from 5 to 16 bits, and word sync can be any 2 bits at any location within the word. Frame sync may be the first or last word of the frame, as selected, and any frame sync code pattern set up by the operator may be recognized.

Circle No. 237 on Subscriber Service Card

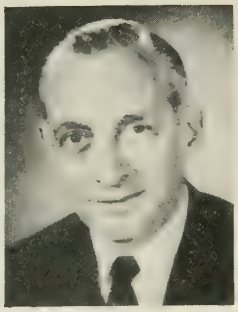
# names in the news



CENTER



KING



CLARK

**Dr. Mervin J. Kelly:** Research engineer and electronics scientist, appointed a special consultant by **James E. Webb,** Administrator of the National Aeronautics and Space Administration. He will investigate a number of areas where space science and technology may have practical applications at an early date and will advise the Administrator on matters of related space sciences. He was with Bell Telephone Laboratories for 41 years, retiring as chairman of the board two years ago. Since then, he has been serving as adviser to the president of International Business Machines Corporation.

**H. Herbert Jackson:** Named manager of the *Nimbus* weather satellite control system for General Electric's Missile and Space Vehicle Department, Philadelphia. Prior to joining GE, Jackson was an aeronautical research scientist at the NACA Pilotless Aircraft Research Division, Langley Field, Va.

**Dr. Ercole E. Motta:** Appointed director of chemical sciences, Dynamic Science Corporation, San Marino, Calif. He was formerly deputy director of the special products department of the Atomics International Division of North American Aviation.

**William Lawrence** and **Howard L. Gates:** Appointed general manager and manager of operations, respectively, of General Dynamics/Electronics' Military Products Division, San Diego.

**Dr. Claude L. Clark:** Metallurgical engineer, Timken Roller Bearing Co., Detroit, will receive the Albert Sauveur Achievement Award of American Society for Metals. The award is being made in recognition of Dr. Clark's outstanding contributions toward advancing knowledge of metalworking technology.

**Dr. Jean I. F. King:** Former manager of Physics Operations at General Electric's Missile and Space Vehicle Department, Philadelphia, appointed director of Plasma Physics Laboratory of Geophysics Corporation of America, Bedford, Mass.

**J. M. Cummings:** Named manager of Space Engines, a new subdivision of Research and Engineering at Rocketdyne Division of North American Aviation, Inc., Canoga Park, Calif. Previously he was manager of Rocketdyne's Small Engines subdivision in Liquid Propulsion Engineering.

**Maurice Center:** Joins the Astrionics Division of Fairchild Engine and Airplane Corporation, Wyandanch, Long Island, N. Y., as general manager. Center was formerly program director for the "Missile Master" Air Defense Coordination System of The Martin Company.

**Dr. Charles F. Gell:** Chief of life sciences for the Astronautics Division of Chance Vought Corporation, appointed clinical professor of physiology at the University of Texas' Southwestern Medical School in Dallas, to further the joint efforts of both organizations.

**Alfred H. Canada:** Former technical consultant on infrared and optical techniques for the Advanced Research Projects Agency, named manager of engineering for Raytheon Company's Santa Barbara Operations.

**Dr. James H. Gardner:** Elected a vice president of National Research Corporation, Cambridge, Mass., and will continue to serve as general manager of the Metals Divisions.

**Frank H. Gardner** and **Martin Schletter:** Veteran development engineers of Tenney Engineering, Inc., Union, N. J., named managers of the newly-organized Aerospace Division and the Environmental Division, respectively.

**Peter Churm:** Named vice president of The Fluorocarbon Company, Anaheim, Calif. Churm will continue as general manager of the Teflon and Kel-F processor and fabricator.

**Harley D. Peter:** Formerly of Vitro Electronics, joins Communication Electronics, Inc., Bethesda, Md., as a senior electronic engineer.

**Armand A. Lakner:** Named aeronautical and space scientist, Systems Analysis Office of the National Aeronautics and Space Administration, Washington, D. C. Lakner formerly was with Lockheed Aircraft Corporation, Marietta, Ga.

# letters

## Report on Guidance

*To the Editor:*

I have just finished reading M/R' 4th Annual Electronics Issue (Feb. 27 and want to compliment you on you handling of the subject. In particular I feel that your round-up on guidanc as covered in the "Market Outlook story was unusually newsworthy an comprehensive.

Mike Cannon
Librascope Div.
General Precision, Inc
Glendale, Calif.

*To the Editor:*

I have delayed commenting on you Electronics Issue until I was able t peruse the magazine at some length This was accomplished with difficulty because the copies were snatched fron me almost instantaneously by variou and sundry sales, contracts, planning and engineering people.

Reader interest in the guidance an control equipment issue has been tre mendous, I understand. I'm one of th crowd. It was very well done an highly informative.

Robert S. Knapp
Sperry Gyroscope Co
Great Neck, N. Y.

*To the Editor:*

(The issue) is a great comprehensive coverage of guidance and the treatment was impartial and generous.

We ordered reprints for distribution at the IRE Convention in New York Coliseum.

Wallace C. Baker
American Bosch Arma Corp.
Hempstead, N. Y.

## Man-Machine Discipline

*To the Editor:*

Permit me to express my appreciation for a fine job of technical reporting by Charles D. LaFond in his article, "How Can Pilot Best Control Ship's Attitude?" (M/R, March 6, p. 36).

His point that "Only the surface has been scratched in this quest for critical knowledge" is well taken. Lear, through its Advance Engineering Division, is deeply entrenched in the overall, complex study of how best to design the machine to obtain optimum man-machine performance. A scientific method of approach to this optimization has been sorely needed in past systems; the success of future system complexes may well be dependent upon the successful establishment of such a scientific discipline.

C. E. Barlow
Mgr., Advance Engineering Div.
Lear, Inc.
Grand Rapids, Mich.

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SPACE MEDICINE?





# —when and where—

## APRIL

**International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Institute of the Aerospace Sciences, AFOSR, ONR, U.S. Army Signal Corps.,** Auditorium of the Engineering Societies Bldg., New York City, April 4-6.

**American Rocket Society, Lifting Reentry Vehicles: Structures, Materials and Design,** Palm Springs, Calif., April 4-6.

**Society of Automotive Engineers, 1961 National Aeronautic Meeting,** New York City, April 4-7.

**American Society for Testing Materials, Symposium on Materials and Electron Device Processing,** Benjamin Franklin Hotel, Philadelphia, April 5-7.

**Institute of the Environmental Sciences, Annual Meeting and Equipment Exposition,** Sheraton Park Hotel, Washington, D. C., April 5-7.

**American Institute of Chemical Engineers, Management Engineering Conference, sponsored with AIEE, ASME, IRE, AIME,** Statler Hilton Hotel, New York City, April 6-7.

**Six Lectures on Synthesis of Intelligent Behavior, sponsored by Institute of Radio Engineers, and Society for Industrial and Applied Mathematics (SIAM) University of Pennsylvania,** Philadelphia, beginning weekly April 10 to May 15.

**ASME Maintenance and Plant Engineering Conference,** Bancroft Hotel, Worcester, April 10-11.

**The Combustion Institute, Western States Section,** Aeronutronic Division of Ford Motor Co., Newport Beach, Calif., April 10-11.

**Cincinnati Sections of the Society for Applied Spectroscopy and Instrument Society of America, Symposium,** Cincinnati Gardens, Cincinnati, April 11-12.

**Air Force Office of Scientic Research, Conference on Ultrapurification of Semiconductor Materials,** New England Mutual Hall, Boston, April 11-13.

**Symposium on Information and Decision Processes,** Purdue Univ., Lafayette, Ind., April 12-13.

**Cincinnati Section IRE, and Southern Ohio Section of American Rocket Society, 15th Annual Spring Technical Conference, Electronic Data Processing,** Hotel Alms, Cincinnati, April 12-13.

**Institute of the Aerospace Sciences, Army Aviation Meeting** (classified), Washington, D. C., April 13-14.

**Seventh Military Operations Research Symposium, ONR,** at Boeing Airplane Co., Seattle, April 17-19.


CLASSIFIED

**Army Navy Country Club**

Is offering for sale 475 acres located on Route 28 at Chantilly, Virginia in the immediate vicinity of Dulles International Airport. Write or call Richard E. Daley, General Manager, Army Navy Country Club, Arlington 4, Virginia.


## Advertiser's Index


AC-The Electronics Div., General motors Corp. ..... 12
Agency—D. P. Brother & Co.

American Machine & Foundry Co.-Government Products Group ..... 33
Agency—Cunningham & Walsh, Inc.

Avco Corp. ..... 18
Agency—Benton & Bowles, Inc.

Boeing Airplane Co. ..... 29
Agency—Fletcher, Richards, Calkins & Holden, Inc.

Cannon Electric Co. ..... 8
Agency—Anderson-McConnell Adv. Agency, Inc.

Donner Scientific Co.-A Sub. of Systron Donner Corp. ..... 52
Agency—Bonfield Assoc., Inc.

Government Products Group-American Machine & Foundry Co. ..... 33
Agency-Cunningham & Walsh, Inc.

Hughes Aircraft Co. ..... 51
Agency—Foote, Cone & Belding

Kollmorgen Corp. ..... 10
Agency—Wilson, Haight & Welch, Inc.

McCormick Selph Associates ... 43
Agency—Long Advertising, Inc.

Monsonto Chemical Co., Corporate Div. .....2, 3, 4
Agency—Gardner Advertising Co.

New Departure Div.-General Motors Corp. ..... 37
Agency—D. P. Brother & Co.

Phoenix Products Co. ..... 7
Agency—Ken Seitz & Associates, Inc.

Radio Corp. of America, Industrial Electronic Products ..... 25
Agency—Al Paul Lefton Co., Inc.

Technic, Inc. ..... 41
Agency—Lanning Assoc., Adv.

Texas Instruments, Inc., Semiconductor-Components Div. 6
Agency—Don L. Baxter, Inc.

Vitro Labs, a Div. of Vitro Corp. of America ..... 20
Agency—Sam J. Gallay Adv.



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# Odd Caution on the New Frontier

CHANGES IN THE FISCAL '62 missile/space budgets outlined by President Kennedy are certain to run into strong opposition in Congress and elsewhere.

His amendments to the Eisenhower budget call for increased military spending of $650 million with new obligational authority of nearly $2 billion. The budget increase for the National Aeronautics and Space Administration totals $85 million with new obligational authority of $125 million.

This hefty financial shot in the arm is welcomed by the industry. But it seems to have been achieved with a hodgepodge of compromise certain to arouse the wrath of influential members of Congress and the industry.

An outstanding example of this is the decision to once again cut back the B-70 program—but not all the way. This seems like a sure way to anger both B-70 supporters and those B-70 critics who feel the program should be dropped.

The President has said, in effect, "We don't really think much of the B-70 but we're going to buy a few, anyway." It's an approach that smacks a little too much of political expediency. The program should either be killed or implemented in a sensible fashion. There's a lack of courage in the present position.

Subcontracting on the B-70 program has been extensive. Hundreds of firms are involved. How anyone can expect them to carry out sound financial planning in a program that has become a political football escapes us.

Additional furor can be expected over the *Nike-Zeus* decision. The Army has gathered strong support on the Hill for its plan to push *Zeus* into production as soon as possible. The Administration has decided to mark time until after the Pacific tests.

And where is the money in the NASA budget to exploit the potential of the breakthrough in solids? The decision to accelerate the *Saturn* program and to step up funding of the F-1 engine is commendable. But aren't we willing to risk anything on the possibility of a really significant return on a strongly-backed solid booster program? Or will we wait until the Russians demonstrate what can be done?

Certainly there will be no strong opposition to the increase in spending in the *Polaris* program. Nor can there be informed opposition to most of the cutbacks in the revised budget. The implication that *Polaris* is replacing the mobile *Minuteman* will draw no arguments from anyone who has seen what war can do to a railroad. This and cancellation of the two *Titan II* squadrons have been offset to a certain extent by approval of three additional *Minuteman* fixed squadrons.

The death blow to the *Eagle-Missileer* program will be a severe jolt to the companies involved. But the Administration should find it relatively simple to defend its refusal to fund a new subsonic aircraft and a Mach 3 missile for defense of aircraft carriers.

The nuclear aircraft program has limped along for too many years, spending too many dollars; it's doubtful that anyone will shed too many tears over it.

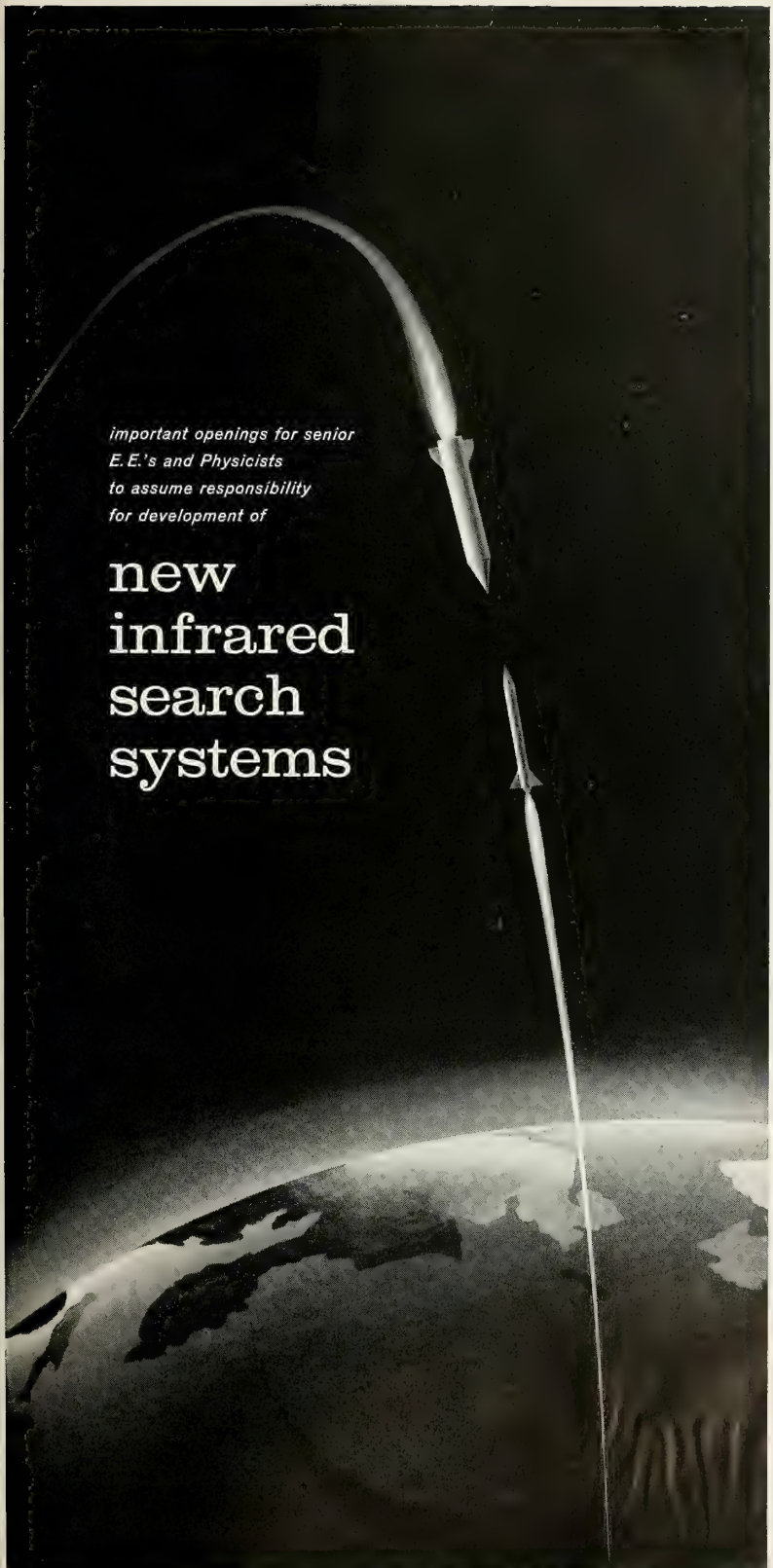
OVERALL, IT IS NOT the cutbacks in the revised budget which we deplore. It is the failure to take the limited financial risk of exploiting the promising new projects and programs.

The Eisenhower-Kennedy budget as it stands is a patchwork document resulting from the necessity of a too-hasty review by the Kennedy Administration. This certainly is one of the penalties of the administrative changeover required by our democratic form of government.

But we find the cautious wait-and-see attitude of these New Frontiersmen a little strange. We always thought a willingness to take a courageous gamble was necessary to build a new frontier.

We look forward to the Kennedy Fiscal '63 budget in the hope it will reflect the sensible but bolder approach of a longer period in office.

**William J. Coughlin**




Progress of the Hughes Infrared Systems and Guidance Heads Department reflects Hughes' overall growth. In the past ten years, employment has risen from under 2,000 to over 30,000 in semi-autonomous divisions concerned with Engineering, Research, Commercial Products, Ground Systems, Communications and Manufacturing. The infrared activity includes these typical projects:

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7. **Detector Application Physics**
8. **Optical Systems Design**

These activities have created a number of new openings for graduate engineers and physicists with analytical and inventive abilities.

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The importance of infrared development at Hughes is shown in substantial development contracts and in the fact that Hughes is investing its own funds in further exploration.

We invite your earliest inquiry. Wire collect, or airmail resume directly to:
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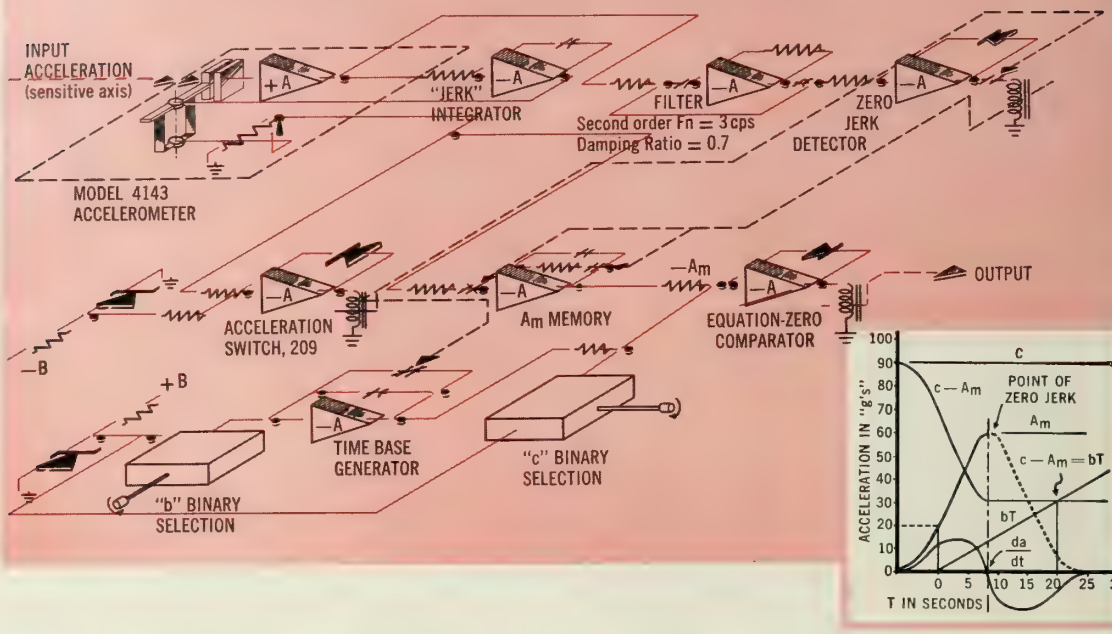
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Functional Diagram of Donner Accelerometer Timer Switch. Basically an airborne computer designed to solve a specific equation, this Donner device consists of a force balance accelerometer, whose output feeds to a jerkmeter for determination of peak acceleration (Jerk (da/dt) is the first derivative of acceleration). From the jerkmeter the signal passes through a filter and to a zero jerk detector which closes a switch at the peak acceleration. Other units in the computer are a peak acceleration memory, a 20 g acceleration switch which starts a time base generator and prevents the zero jerk detector from operating before a correct solution is possible, "b" and "c" selection binary units allow 64 values of "b" and "c" to be selected within the operating range, and an equation zero comparator which algebraically sums the output of the maximum acceleration memory circuit, time base multiplied by "b" and "c" circuit to close the relay output when $bT = c - A_m$. The curve below illustrates the equation and the fact that peak acceleration occurs at zero jerk.




# How to Solve a Flight Equation

## *New Donner Airborne Analog Computer solves equation* $bT=c-A_m$

where b = predetermined constant, T = time in seconds, c = predetermined constant, and $A_m$ = peak acceleration achieved.

Causing a missile event to occur at just the right time and place in space is one of the critical problems faced by the control engineer. The programming device must be light, accurate, strong and, above all, reliable in severe environments.

When Donner engineers were confronted with this problem, they came up with a fixed purpose airborne analog computer known more specifically as an acceleration summing switch. The summing switch is a "thinking" device which responds to a particular environmental stimulus. Thinking for the vehicle, the switch measures time, multiplies it by a preset constant, equates the product to the memorized peak acceleration subtracted from a constant and when the sum reaches a predetermined value, actuates a relay. Such a point occurs during decreasing acceleration and is dependent on the magnitude of peak acceleration.

In solving this problem, Donner engineers combined their experience with computer techniques and servo force balance accelerometers. The device illustrated is all solid state.



**Acceleration Summing Switch.** This remarkable small computer is approximately 4" high and 2½" across. The two knobs on the top are used to set in "b" and "c" constants of the equation.



**COMPLETE TECHNICAL INFORMATION AVAILABLE**
If you would like more information about this interesting application of computer and transducer techniques, our Mr. Stephen P. Cuff has prepared a technical discussion which he will be happy to send along. Please write Mr. Cuff at Donner Scientific.

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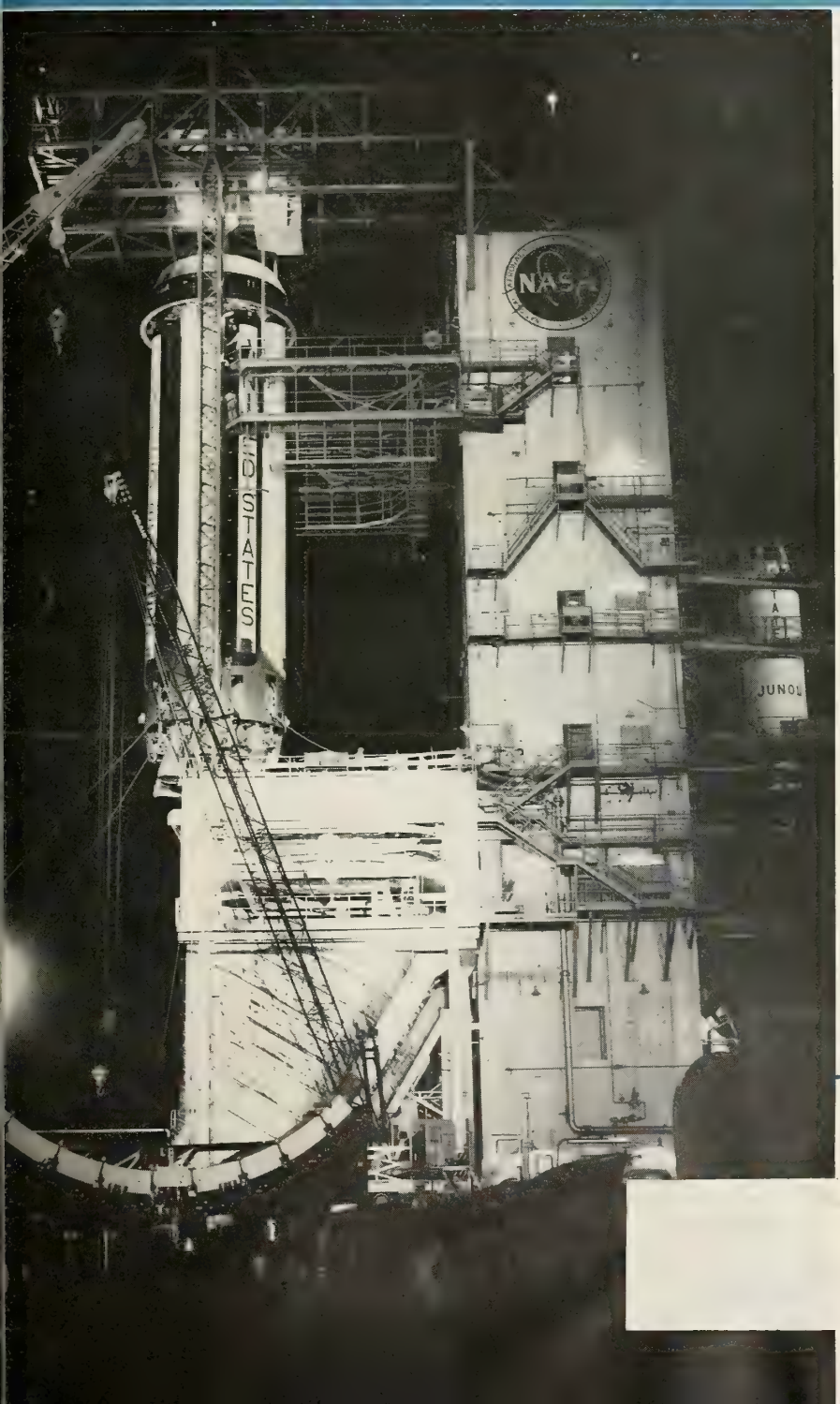
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APRIL 10, 1961

# missiles and rockets

THE MISSILE/SPACE WEEKLY

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## British See U.S. Effort To Corner Market for Missiles

- **Two Engines Added to Saturn**
- **Unique Mk73 Directs Tartar**
- **Glasrock's Wide Potential**

*Saturn Awaits Static Test*



*Bell's All-weather Automatic Landing System—symbolized.*

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The system has been flight-proved in more than 4,000 landings with all types of aircraft—small private planes as well as airliners from the DC-3 and DC-7 to the huge Boeing 707 jet. It now is being evaluated at FAA's National Aviation Experimental Center, Atlantic City, N. J.

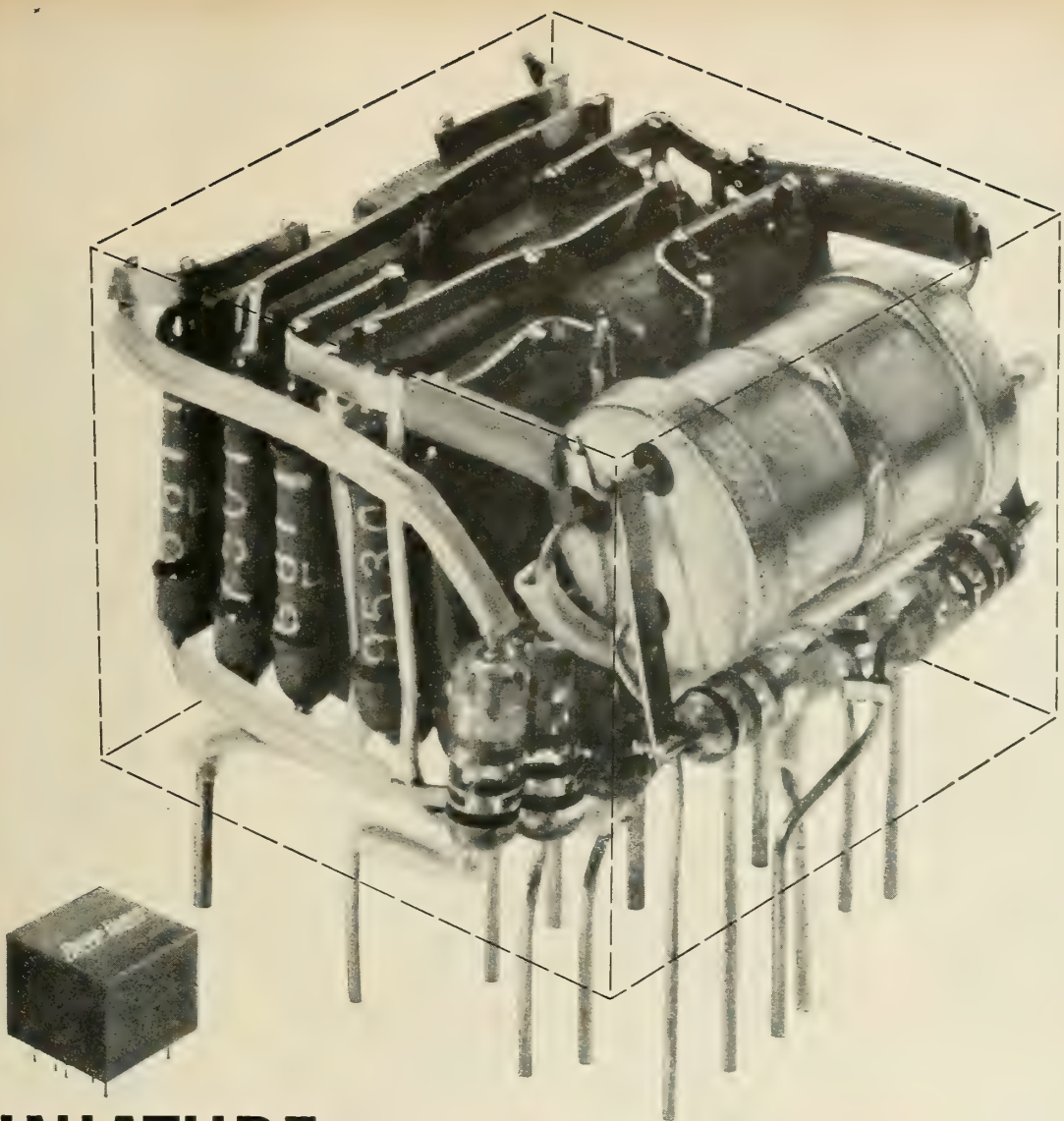
Unlike other automatic landing systems, the Bell ALS is ground-based so a ground observer monitors every approach and landing. It can operate either fully automatically or under pilot control.

Military versions of the ALS have been ordered by the Air Force. The Navy has selected it for installation aboard the nuclear-powered aircraft carrier USS Enterprise as well as for its other large carriers.

The Bell ALS is but one among many contributions which Bell Aerosystems Company is making to the scientific progress and defensive strength of the free world. We invite qualified engineers and scientists to inquire about sharing our challenging and rewarding future.

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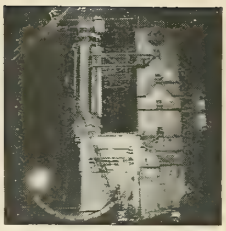
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## THE COVER

*Flight model of Saturn booster waits on stand at NASA's Marshall Center for first static tests. Second-stage configuration has been changed to six engines. See p. 16.*

## APRIL 10 HEADLINES

British Warn Against U.S. Missile Monopolizing ..... 13
Breakout of Kennedy's Military Spending Budget ..... 15
NASA Adds Two Engines to Saturn C-2 Second Stage ..... 16
U.S. Pumps More Funds into Development of Centaur ..... 17
Revised Data Shows X-15 Climbed to 32 Miles ..... 19
Kennedy Asks Doubled Funding of Oceanography ..... 24
ARS Re-entry Meeting Told of 'Whisker' Progress ..... 36

## ELECTRONICS

Tartar's Mk73 Director is Outstanding in Field ..... 22

## ADVANCED MATERIALS †

Glasrock Ceramics Have Vast Range of Application ..... 26

## SUPPORT EQUIPMENT

B-58 Defense Simulator Sharply Cuts Training Cost ..... 29

## PROPULSION ENGINEERING *

Major Missiles Switching to Glass-Plastic Cases ..... 32

## SPACE SYSTEMS

LOFTI Findings Change Standard Concepts of VLF ..... 35
Discoverer XXII's Failure to Orbit Investigated ..... 35

## INTERNATIONAL

Franco-British Study Sees Satellites up by 1964 ..... 37
Aussies' Malkara Is Deadly Bunker Destroyer ..... 38

## MANAGEMENT

Government Property Regulations Need Overhauling ..... 41

## DEPARTMENTS

The Countdown ..... 7
The Missile/Space Week † ..... 10
Technical Countdown ..... 21
Industry ..... 39
Names in the News ..... 43
Contracts ..... 44
Reviews ..... 44
Products & Processes ..... 45
Letters ..... 48
When and Where ..... 49
Editorial ..... 50

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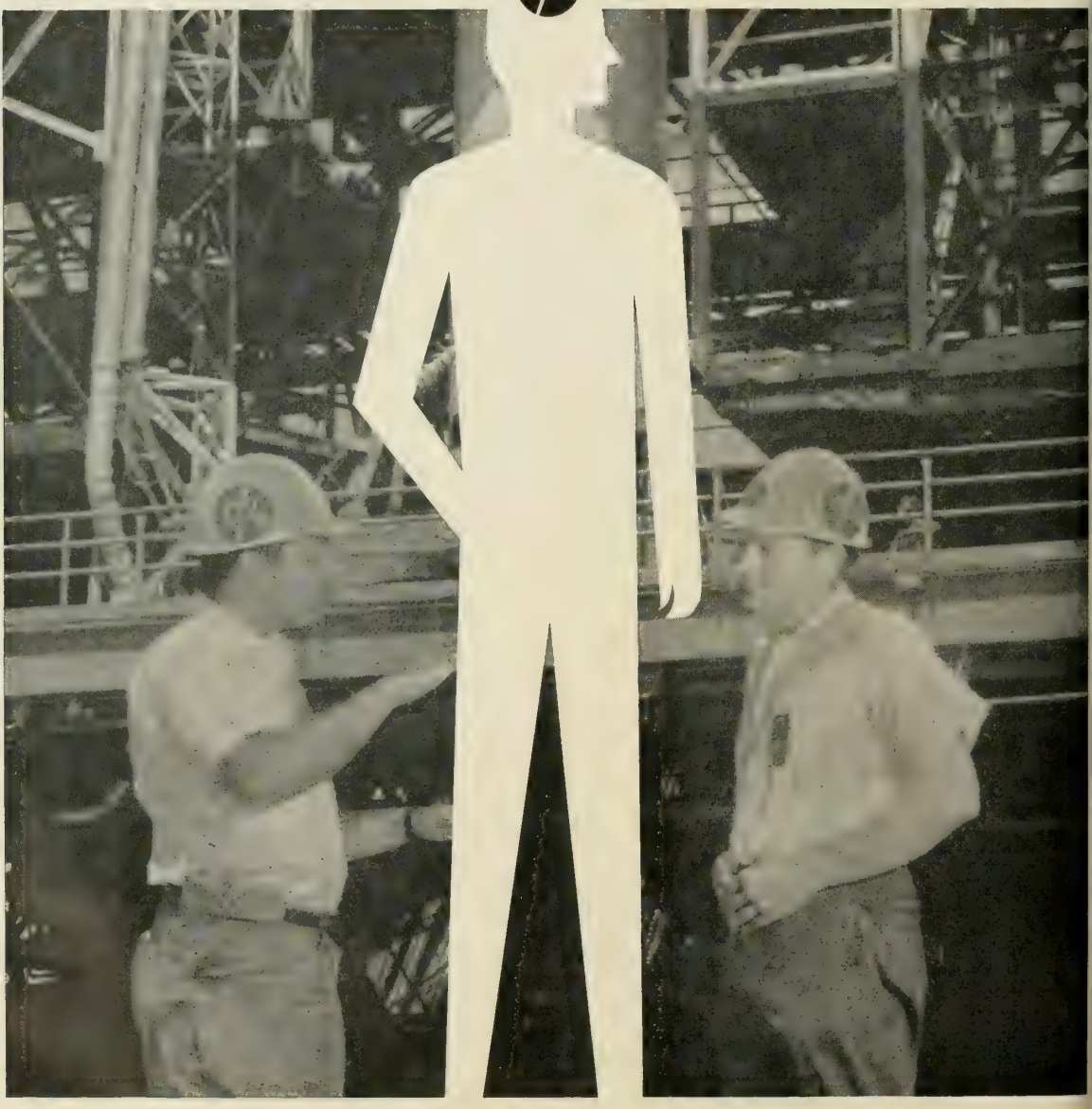
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# The Countdown

## WASHINGTON

### Two-Ocean Polaris Fleet Ahead

The Kennedy Administration plan to boost the *Polaris* fleet to 29 submarines gives the Navy the start of a two-ocean *Polaris* force. The next step: Selection of a Pacific *Polaris* Depot. Insiders are betting on Guam. The Navy is expected eventually to deploy two nine-ship *Polaris* squadrons in the Pacific, three in the Atlantic.

### Hound Dog Reach Grows

The range of the North American *Hound Dog* is now proven to be in the 600-mile class—a 20% increase over previously announced specifications. The air breathing air-to-surface missiles are being deployed with all B-52 jet bomber squadrons.

### STOL's—Not Choppers—for Missilemen

The Air Force, at least for the present, has decided to provide its ICBM squadrons with light STOL aircraft rather than helicopters for hauling missilemen and supplies from central bases to dispersed launch sites. Twenty-nine planes will be bought in FY '61; another 47 in FY '62. Some helicopters still may be bought later. Both STOL aircraft and choppers were tried out at Warren AFB's *Atlas* sites.

### Mace B Readied for Overseas

The first squadrons of the new Martin *Mace B* are scheduled to be deployed with U.S. forces overseas this summer. The *Mace B*, unlike *Mace A*, can operate over water. Also unlike *Mace A*, the new models will be deployed in hardened launch sites. Probable deployment site: Okinawa.

### First Missile Carrier to Join Fleet

The 60,000-ton Kitty Hawk, first carrier to be armed with missiles, will be commissioned April 29. The Forrestal Class carrier will be armed with Convair *Terriers*. She will have two *Terrier* launchers—port and starboard aft.

### Offer Without Takers

NASA is permitting Russian and other Iron Curtain country newsmen to enter Cape Canaveral for the first time to witness the *Mercury Redstone* manned ballistic shot a few weeks from now. So far, however, there have been no takers.

## INDUSTRY

### Germans Stop Mace Production

West Germany is understood to be reviewing its defense needs and COUNTDOWN hears that one result has been to call off production of *Mace B*. Termination notice went to Martin Co. last month. The order for Germany had been tacked onto the end of the Tactical Air Command *Mace* order, so there will be no immediate effect from termination, except on some subcontractors. Award of the contract for the West German *Maces* was made last November, but never announced in order to avoid criticism that the U.S. was arming a former enemy.

### R&D Intelligence

Trend now in glass-plastic rocket motor cases is toward single nozzle design, with nozzles wrapped integrally with the case. This requires a secondary system for thrust vector control, which is justified by design and weight advantages. . . . GE-Philadelphia has a 12-month NASA study contract on the feasibility of a magneto-hydrodynamic propulsion system powered by SNAP-8. . . . Aluminum-coated fiberglass containing U3P8 is being roll-cladded by Clevite Corp. as fuel elements for nuclear reactors.

### Arc-jet Studies Extended

Six months and $50,000 are being added by NASA to two competing contracts for developing laboratory models of arc-jet engines. Avco-Wilmington and GE-Cincinnati have been working on the engines under $250,000 contracts for the past year.

### Nuclear Rocket Pushed

With the development of *Saturn* in sight, the push is on to start developing a nuclear rocket upper stage. Martin Co.'s William Bergen contends RIFT (reactor-in-flight-test) study for NASA shows a 1966-67 target date to be "realistic" and that with *Saturn* a nuclear system could put 35 tons in orbit. . . . Two Douglas Aircraft engineers are advancing a plan for a nuclear electric rocket which would be propelled by supercharging a solid core reactor, using highly efficient thermionic units to speed gas flow with electrical and magnetic fields. . . . Reasoning behind NASA-Huntsville's study plan for launching *Saturn* from a Texas Tower-type pad in the sea off Cape Canaveral is safety when a nuclear stage is flown.

## INTERNATIONAL

### New British Secret Missile under R&D

COUNTDOWN hears that one of the most closely guarded new missile projects in Britain is work on an advanced antisubmarine missile. This may explain much of the recent alarm over the British spy trial involving the Royal Navy underwater test station.

### Space Club Troubles

Italy is declining to join in a cooperative European satellite launching program because it doesn't want to make any commitment "on specific vehicles and/or hardware" already in existence. However, the country will stay in the European Space Research Organization.

### Overseas Pipeline

Electronic divisions of Armstrong Whitworth Aircraft and Brush Electrical Engineering, both members of the Hawker Siddeley Group, are consolidating. . . . The British are said to be investigating radio signals being beamed from the Scottish mainland to Russian trawlers lying in an area where *Polaris* subs must pass after leaving Holy Loch. . . . and there's a report the Soviets at one of their R&D centers already are building a prototype of the caterpillar moon-crawler depicted in their space literature.



It's the point where men will first rendezvous in space. It could be any point. The trick is getting two men there at the same moment when they're traveling at orbital speeds or greater.

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# The Missile/Space Week

## Labor Trouble at Lowry

Walkout of 400 Martin workers at the *Titan* Site 1-A near Lowry AFB, Denver, will affect the operational status of that site on a one-to-one basis, the Air Force has charged. This means that every day lost during the walkout will push back the operational date—set for late summer—by one day.

The work stoppage occurred over a jurisdictional dispute between the United Auto Workers Union and the Operating Engineers Union over powerhouse operations. The Martin Co. has denounced the walkout as "unfair" and has turned over the matter to the National Labor Relations Board. The stoppage has not been termed a "strike" since there is no picket line operating as yet.

The action apparently was triggered by a few protesting operating engineers. Some 25,000 man days have already been lost through strikes and walkouts since the beginning of construction at the Lowry *Titan* emplacements, an Air Force official estimated.

## Holes for Minutemen

Test borings will begin shortly at Air Force bases in three states for the three *Minuteman* squadrons designated in the Kennedy budget.

Surveys are being conducted for possible hardened bases at Tinker AFB, Oklahoma City, Reese AFB, Lubbock, Tex., and Whiteman AFB, Knob Noster, Mo.

A $1-million contract for five *Minuteman* emplacement systems was let by Boeing last week to The Bendix Corp.

The system includes a hydraulic power supply, two erector-activators, a hoist, control panel and interconnecting equipment for lowering the missiles into underground launchers.

Delivery of the first unit is scheduled for this fall.

## Shot of the Week

The fizzle of a *Titan* missile Mar. 31 slightly dimmed the Air Force's elation over a perfect shot just two days before. The Martin-built bird was scheduled for an extended range trip of about 10,000 miles, but plopped into the ocean soon after launch, apparently due to a premature first-stage cutoff.

## Army Missile Contracts

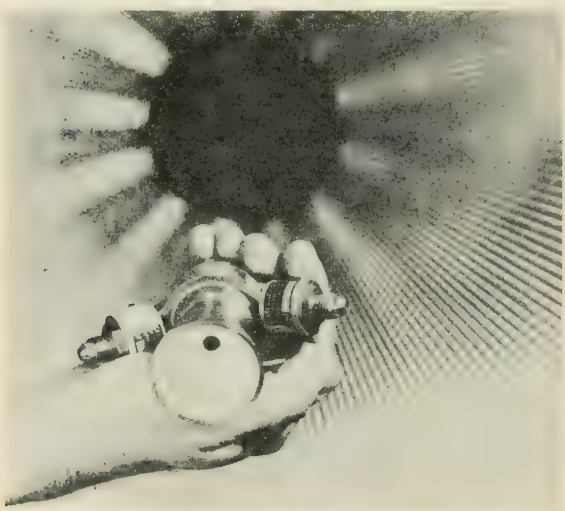
The Army awarded some $70 million in missile contracts last week.

Raytheon Co. received $57 million in contracts on the *Hawk* missile system and ground support equipment, including $20 million for missiles.

Sperry Rand's Utah division got a $6.8-million contract for continued production of the *Sergeant* missile, and Convair Division of General Dynamics copped a $5.9-million follow-on contract for *Mauler* antitank missile production.

## Nerva Prime Contest

Seven companies filed proposals with the NASA-AEC Nuclear Propulsion office last week for the prime contract on the Nerva nuclear rocket



### Compact Power Package

*ONE-POUND ROCKET ENGINE developed by Reaction Motors, Thiokol Chemical Corp., delivers controllable pulses as frequent as 22.5 per second for attitude control and station keeping of satellites. Available in thrust ratings from ½ to 10 lbs. the Starmite rocket occupies 5 cu. in. It operates uncooled for extended periods on various self-igniting liquid bipropellants. Continuous firings as long as 10 min. have been recorded.*



### 'Mother-Daughter' Talk

*TINY RECEIVER for 72-megacycle signals proposed for ionospheric studies. Under a $25,300 NASA contract, Pennsylvania State University is studying plan to launch twin payloads with Javelin rockets to altitudes up to 1500 miles. "Mother" and "daughter" would then separate, and electron density would be measured by comparing phase differences between signals on 6, 12 and 72 mc transmitted from "daughter" to "mother."*

engine, the flight engine for Project *Rover*.

The contract—expected eventually to lead to $1 billion in business over the next decade—is expected to be awarded in six weeks to two months. Bidders are Rocketdyne Division, North American Aviation; Aerojet-General Corp.; Pratt & Whitney Division of United Aircraft; Reaction Motors Division, Thiokol Chemical; Westinghouse; General Electric; and American Metal Products Co., Ann Arbor, Mich.

The initial contract will call for only the first phase of the program—providing backup and assistance for AEC's Los Alamos Scientific Laboratory in preparations for the *Kiwi-B* test later this year. The size of the job to be done in the first phase will depend on how much money Congress appropriates for *Rover* in the coming weeks.

## And Bids on Rebound

NASA's Goddard Space Flight Center received bids from eight companies last week on spacecraft design and development of orbital placement technique for the Project *Rebound* communication satellite system.

*Rebound* calls for multiple launchings of 135-ft.-diameter rigidized *Echo*-type spheres. First launching—in mid-1963—will be three aboard an *Atlas-Agena B*. Later launchings call for six satellites on a *Centaur*.

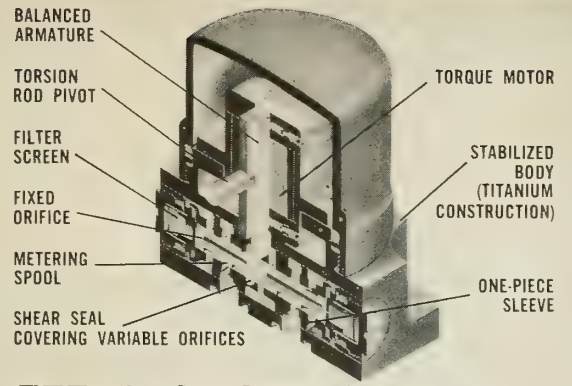
Bidders were AMF, Lockheed, Convair, Goodyear Aircraft, RCA, Republic Aircraft, Avco and Douglas. Actual fabrication will take place under a later-phase contract.

## U.N. Meeting Not in Cards

The United Nations Conference on Peaceful Uses of Outer Space seems to be out for 1961.

No negotiations have been held between the United States and Russia on the subject since the Kennedy Administration took office in January. Since eight months of lead time is considered necessary for planning, U.S. diplomats now have almost given up any hope of holding it this year, as originally proposed.

There is some speculation that the conference might be included in a package agreement with Russia on a group of related subjects.


# A FEEDBACK SERVO VALVE WITHOUT SPRINGS OR LEVERS

- Unity coupled Hydromechanical Feedback
- High Null Accuracy ■ Only 2 moving parts
- Large, full opening, shear-seal orifices

This two-stage, four-way flow control valve is the only one available that provides true positional feedback without springs or levers. The first stage consists of an electrical torque motor and "shear-seal" orifice hydraulic amplifier, while the second or control stage is made up of an accurately matched spool and sleeve arrangement.

Hydromechanical unity feedback relates spool position to torque motor armature position and also nulls out effects of orifice variations due to supply pressure and temperature fluctuations. Flow force reactions are thus substantially reduced and hydraulic centering of pilot position is feasible without spring hysteresis and null shift. Large orifices prevent clogging and silting and high shear forces permit efficient operation even with highly contaminated fluids. Final null adjustments are made electrically by a balancing control at amplifier output stage.

## TYPICAL CHARACTERISTICS

| | Medium Flow (#6103-#6106) | High Flow (#6104) |
|---|---|---|
| Rated flow | to 7.5 gpm at 3000 psi valve pressure drop | to 18.0 gpm at 3000 psi valve pressure drop |
| Hysteresis | 3% maximum total rated current | 3% maximum total rated current |
| Supply pressure | 300 to 3000 psi | 300 to 4000 psi |
| Proof pressure | 4500 psi pressure port 3000 psi return port | 6000 psi pressure port 3000 psi return port |
| Pressure gain | First stage—500 psi per ma minimum with 3000 psi supply | First stage—500 psi per ma minimum with 3000 psi supply |
| Load pressure gain | 8500 psi per ma minimum with 3000 psi supply | 10,000 psi per ma minimum with 3000 psi supply |
| Temperature | —65°F to +275°F | —65°F to +275°F |
| Maximum Null Shift (% of rated current) | | |
| Temperature Change per 100°F | 1% | 1% |
| Supply Pressure Variation ± | 2% | 2% |
| Quiescent Current Change 20% | 1% | 1% |
| Weight | 12 ounces | 16 ounces |

**TORQUE MOTOR:** Note: 6103 & 6106 Identical with exception of torque motor characteristics.

| | Valve #6103 | Valve #6105 |
|---|---|---|
| Input Power | 300 Milliwatts | 64 Milliwatts |
| Rated Current | ± 10 ma | ± 8 ma |
| DC Coil Resistance (other motors also available) | 3000 ohms/coil | 1000 ohms/coil |

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KEARFOTT DIVISION
GENERAL PRECISION, INC.

*Little Falls, New Jersey*




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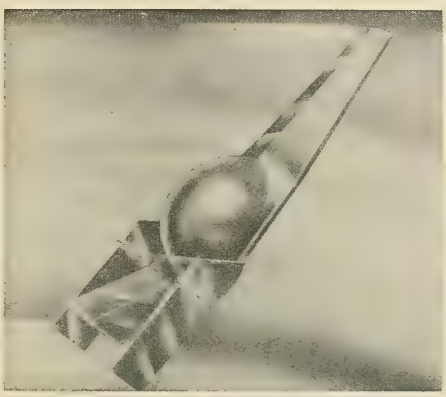
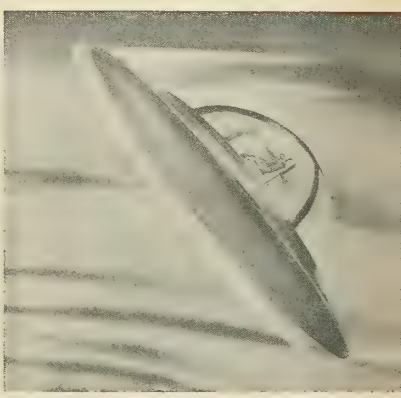
**Hit the moving target sooner!** Make the missiles fly faster. Increase payloads, increase range, decrea missile size! ■ These urgent demands call for more push per pound of solid propellant—and per dolla And squeezing more and more energy out of fuels is a big part of our solid work at GCR. Recent exampl Nitroplastisol—new double-base composite-type propellant. Immediate application: Army's new Maul mobile ground-to-air missile. Future uses: high mass-ratio upper-stage motors, small ICBM, ejection moto orbit and retro motors, and many more. **GRAND CENTRAL ROCKET COMPAN**

REDLANDS, CALIFOR



# British Missile Men Warn Against U.S. Drive Toward Monopoly

***Blue Water vs. Sergeant is immediate argument; Franco-British study stirs interest in West Germany and Italy***

*IDEAS FOR MANNED spacecraft being advanced by British Missile Men.*

**by James Baar**

LONDON—British industrialists are charging privately that elements of the U.S. Missile/Space Industry are trying to monopolize the missile and space market in the West.

The British contend that if the attempt succeeds it will result in a partial undermining of the European economy and a tremendous gain for the Soviet Union in the East-West space race and the Cold War.

The charge is a major underlying factor in current European talks aimed at establishing a cooperative European space program along the lines of proposals made in the recent Franco-English study produced by SEREB and Hawker-Siddeley Aviation Ltd.

The charge also was a major underlying factor in the recent secret talks in Washington between Defense Secretary Robert McNamara and British Defense Minister Harold Watkinson. It was expected to be an issue at last week's meeting between President Kennedy and British Prime Minister Harold Macmillan.

The message that key industry officials in Britain hope both Watkinson and Macmillan were able to get across is that the United States has far more to gain by sharing the missile/space pie.

The British contend that one of the more outstanding of these gains would be the acquisition—at relatively bargain prices—of a new and large reservoir of first-rank brain power for work on many advanced space study programs.

• **Test case?**—The English Electric missile *Blue Water* is the immediate cause of contention between U.S. and British missile manufacturers.

The *Blue Water* and the American Sperry *Sergeant* are under consideration for filling NATO's requirement for a short-range tactical missile. Both are powered by solid propellant. Both are highly mobile. Both have a range of about 75 or more miles. Both are in production.

The competition from any standpoint is very, very warm.

The British have charged that the United States has brought considerable pressure on the NATO nations to adopt the *Sergeant*. The suspicion has been raised that the Kennedy Administration sees the sale of *Sergeant* to NATO as a boon in helping to halt the flow of gold from the United States.

Whether this is true or not, many British industrialists see *Blue Water* as a test case. As one company official not associated with English Electric put it:

"It's a test of good faith. *Blue Water* is a very fine missile. We think it is better than *Sergeant*. NATO should buy it. If the United States takes away the entire market, we won't be able to continue and the West will be the poorer."

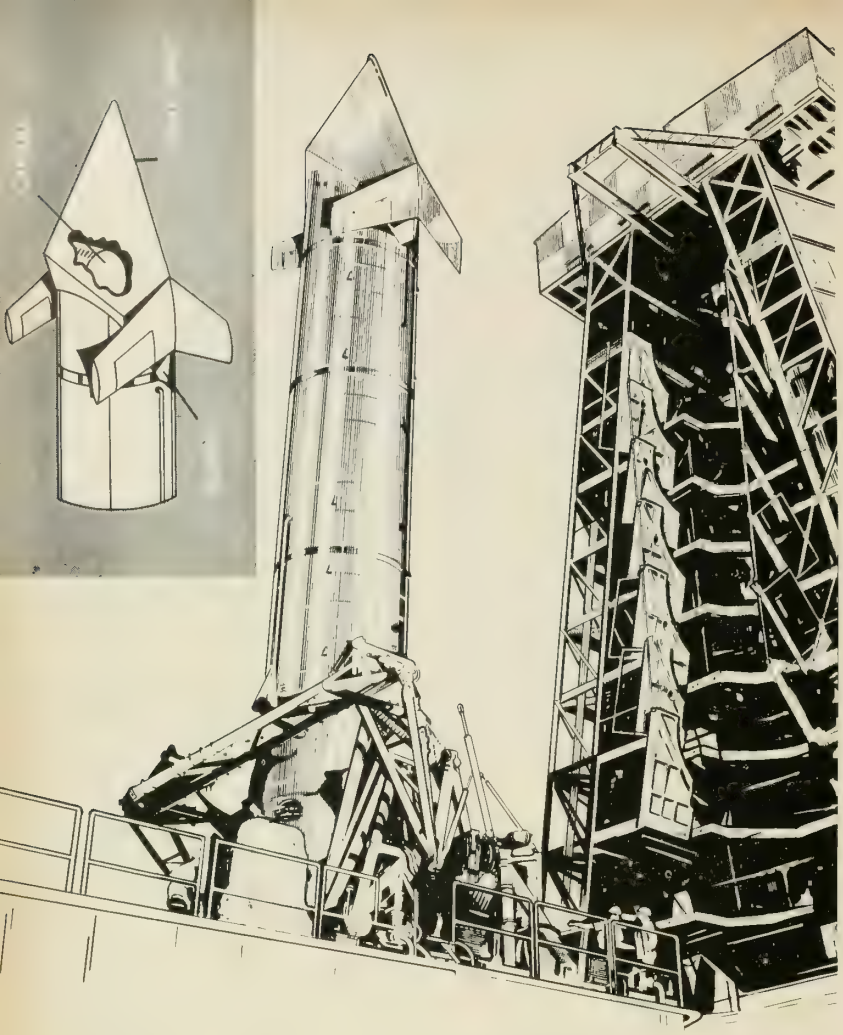
Another official recalled the British decision to buy Douglas *Skybolts* from the United States.

"Here was a situation where we didn't have the missile; therefore we are buying it from Douglas," he said. "This was the cheaper way. There was no sense in us both developing the same thing. We could have, but it made economic sense at least in the short run not to do so."

• **Two-way street**—However, he added pointedly that both the United States and Europe would benefit if such decisions worked both ways.

"After all," he said, "if when the first Model T was manufactured in the United States we had bought it and every model after it and had not made motorcars ourselves we would have had no motorcar industry. Then where

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*BRITISH DYNA-SOAR perched on a de Havilland Blue Streak as envisioned in an 18-month-old technical study by Sir W. G. Armstrong Whitworth Aircraft Ltd. It is one of several advanced studies which the British have completed demonstrating the capabilities which they contend are being left unused.*

would we have been in World War II?"

The SEREB-Hawker Siddeley study sounded these various themes in unmistakably clear tones.

"The progress our nations will make in the field of advanced (space) techniques will be a governing factor as concerns their future place in relation to the great powers of today," the study said.

"Let us suppose for a moment that the European nations show not the slightest interest in aerospace studies. The result would be that the technical and commercial advantages which stem from space ventures would have to be acquired from abroad. Translated into commercial terms, this would mean the purchase of licenses for products and manufacturing methods which would have wide applications . . ."

At another point, the study said "Western Europe represents a vast intellectual potential and it would be unfair to our scientists and designers to pretend that the human resources were not available."

• **Cost and profits**—It said beginning a European space program "boils down essentially to an organizational and financial problem." And, it noted that from a financial standpoint European space programs had a large advantage over American programs.

The study said that because of differing price levels a European space project could be financed for 60% of what it would cost in the United States. Moreover, it said that the "vast expenditure" in the United States on missile and space projects can be attributed in part to circumstances which are "clearly political." Among these circumstances were listed: "Reasons of prestige . . . interservice rivalry . . . and the tendency to do things in a big way."

The study also pointed out that the longing to realize immediate profit was not found exclusively on the western shores of the Atlantic.

"The European countries may be tempted to bring their initial effort to bear on exploiting results already attained," it said. "The extent of available funds to be devoted to this work must remain within acceptable limits so that the research and development of new techniques is not jeopardized."

• **"We can help"**—One little-noted passage in the study was possibly the most significant. It referred to the possibility of a future space war between the East and West.

"For some time," the study said, "a growing number of far-sighted people have warned of the probability of an approaching space war. Space will be the enemy's observation post, the base for attacks against terrestrial targets. And, above all, the place where an attempt will be made to destroy or neutralize the enemy's resources."

One British missile industry official made the point even stronger.

"We are in a period of nuclear deadlock," he said. "Both sides are building up their missile arsenals. Possibly the balance will tilt one way or another. But the Russians see a better way. They are going to reach into space to break the deadlock. If they are successful, there would not necessarily be a war. There will be nothing cataclysmic, just an accommodation."

He smiled and shrugged.

"We can help America in this race," he said. "We might even show America a trick or two. Our people could work on these advance problems which they have no reason to work on now. Then when we have reached a higher stage in our own space progress, we could borrow back the answers.

"Now our talent is being wasted. While Europe and the United States compete to sell a missile or two, Russia goes ahead. But Western Europe doesn't understand; it doesn't see the danger. Neither apparently does America."

• **Stirrings**—However, there are signs of some awakening to the danger.

Companies in both West Germany and Italy have expressed considerable interest in the Franco-British study. Both the British and French governments have shown increased signs of proceeding with a space program alone if necessary.

But it is clear that only fuller cooperation from the United States can give a European program the impetus that it will need for rapid progress. Such cooperation certainly will not be forthcoming from Washington until the Kennedy Administration reaches a decision on what it will do in space itself.

## Preliminary policies . . .

# Defense Plans Could Easily Change

SHARP CHANGES in the nation's efense policies and programs can still e expected from the Kennedy Admin-stration anytime within the next nine nonths.

Defense Secretary Robert McNa-nara conceded this last week that the ew Kennedy defense budget and the olicies on which it is based are only reliminary.

McNamara said his "complete re-ppraisal of our basic national security olicies, plans and programs" may not e completed before Congress adjourns.

This would mean the full impact of he reappraisal would not be felt until he defense budget for FY '63 is put to-ether. However, McNamara said if urther changes are "found to be essen-ial" before then, they will be put before Congress promptly.

Meantime, the Defense Secretary xplained the new obligational authority nd other details of the defense budget n public and secret testimony before the enate Armed Services Committee. He aid:

— The additional $96 million for *Minuteman* included $36 million to louble production capacity; $24 million o extend the missile's 5000-nautical-nile range and improve its "reliability, ccuracy and penetration capabilities;" 10 million to switch from three mobile o three fixed squadrons; and $26 mil-ion for additional training missiles. The witch from mobile to fixed squadrons rought the total number of planned fixed *Minuteman* squadrons to 12—a total of 600 missiles.

**Polaris Sub Commissionings**

| | (Calendar Years) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 |
| Eisenhower Schedule | No. 2-3 | No. 4-6 | No. 7-9 | No. 10-13 | No. 14-18 | No. 19-23 | No. 24-28 | No. 29 |
| Kennedy Schedule | No. 2-3 | No. 4-6 | No. 7-9 | No. 10-18 | No. 19-29 | — | — | — |

—The additional $1.39 billion for *Polaris* included $1.22 billion for 10 submarines, a tender and long-lead time items; $60 million to accelerate R&D for the A-3 *Super Polaris;* $15 million for additional *Polaris* personnel; and $42 million for more training missiles. The speed-up meant that a fleet of 29 *Polaris* subs could be deployed about two years earlier than under the old Eisenhower schedule and added 10 more submarines than Eisenhower had requested.

—An additional $302 million for space research and "other projects" included $30 million for *Dyna-Soar;* $60 million for the *Midas* early warning satellite; $21 million for *Defender* anti-missile system studies; $15 million for the *Advent* communications satellite; $30 million for *Discoverer;* and $14 million for the *Saint* satellite inspection system. "Other" received $132.4 million. Possibly much of it went to the *Samos* reconnaissance satellite. The $30 million for *Dyna-Soar* was only a third of what the Air Force sought.

—The refusal to provide any money for interim production of the *Nike-Zeus* antimissile missile was based on "considerable uncertainty as to its technical feasibility." McNamara said "there are widespread doubts as to whether the *Nike-Zeus* system should ever be deployed." However, he said the Administration was requesting $276 million to continue the *Zeus* R&D program leading to system tests next year.

McNamara said the Kennedy Administration was basing its first defense budget on a policy aimed at reducing "our dependence on deterrent forces which are highly vulnerable to ballistic missile attack or which rely for their survival on a hair-trigger response to the first indications of such an attack."

"Of the four strategic missiles now in production or under development, the *Polaris* has the highest degree of survivability under a ballistic missile attack," he said. "The *Minuteman,* since it can be widely dispersed in well-hardened underground sites, should also have a high degree of survivability." ⌗

## Army to Control Reconnaissance Payloads . . .

KEY AGENCY in a new DOD lan for collecting and plotting recon-naissance data will be the Army's GIMRADA (Geodetic Intelligence Mapping Research and Development Agency) at Fort Belvoir, Va. It will vrite payload specifications.

Defense Secretary McNamara, seek-ng to head off more "overlap and luplication" among the services, last veek assigned the Air Force responsi-ility for collecting reconnaissance data n space and gave the Army the mission f reducing it and processing it.

While the Air Force will perform he actual development of satellite nstrumentation and processing equip-nent, GIMRADA writes the specs—resumably even for the payloads the Air Force is interested in. This latter rovision is understood to be the major reason why the Air Force objected to McNamara's directive reassigning responsibilities. The Air Force also objected to losing control of data reduction.

However, Deputy Defense Secretary Gilpatric maintains there will be no change in the intelligence system for pinpointing Soviet targets. This will remain the responsibility of the Joint Strategic Targeting Center at Strategic Air Command headquarters, Omaha, which will work from original data and photographs provided by *Samos* reconnaissance satellites to locate Russian missile and air bases. But the targets will be plotted on Army maps.

The Army Map Service will set up and manage a single geodetic and mapping program for all three services. This will include a world-wide master geodetic control system and geodetic library.

Gilpatric indicated that the operations of the Air Force aeronautical chart service at St. Louis would be curtailed where they overlap new Army functions.

Gilpatric said the Joint Chiefs of Staff were asked to arrive at a division of responsibility to "eliminate confusion." Their draft of the directive—with the Air Force disagreeing—was used as the basis for McNamara's directive. This was far different from the handling of the directive in which McNamara gave the Air Force the primary military mission in space (M/R, March 13, p. 16). Then, McNamara by-passed the JCS, touching off a furor among the services. ⌗



*FLIGHT-MODEL Saturn booster is lifted onto stand for static tests to begin soon at Marshall Center.*

# Engines Added to Saturn C-1



***NASA ups second-stage configuration from four to six to avoid possibility of slip in schedule; increase to 90,000 lbs. of thrust will enhance maneuverability and control***

**by Jay Holmes**

THE SATURN C-1 second stage will have six engines, not four, with total thrust of 90,000 lbs.

The National Aeronautics and Space Administration decided last week to change the configuration of the Douglas *S-IV* stage, which would have had 70,000 lbs. thrust with four engines.

The Pratt & Whitney *LR-115 Centaur* engine, with 15,000 lbs. thrust, will be used in the new cluster. NASA halted development of the P&W *LR-119*, a follow-on liquid hydrogen-burning engine of 17,500 lbs. thrust.

The change will require some reworking of the *S-IV* vehicle hardware. Douglas Aircraft has been working since last summer under a $65-million contract to develop and deliver 10 of the vehicles, which measure 50 ft. long and 18 ft. in diameter and carry 100,000 lbs. of propellant for a total loaded weight of 110,000 lbs.

• **Delays avoided**—NASA made the *S-IV* change primarily because of concern for meeting schedule. The first *Saturn*—No. 4—with live second stage is to be flown in early 1963. The *LR-115* engine development has run into trouble in the last few months; the first *Centaur* flight has slipped from early summer to the fourth quarter of this year.

*Centaur* uses a pair of *LR-115* engines atop a modified *Atlas* booster. NASA propulsion specialists feared the delay in the *LR-115* would cause comparable delay in the follow-on *LR-119*. Furthermore, they felt that Pratt & Whitney should not be burdened with developing a second engine before the first is out of the woods, and that the relatively small thrust increase attainable with the advanced engine would not be worth the risk of lost time.

High thrust is desirable on the *S-IV* stage so as to give high maneuverability and control from the gimbaling of individual engines. With 70,000 lbs. total thrust, NASA vehicle specialists felt there was only marginal capacity to control the stage. The six-engine cluster will improve control capacity.

NASA vehicle specialists see two other advantages in the change. First, the six-engine cluster consumes the highly volatile cryogenic propellants more rapidly, reducing total burning time from 600 to 433 sec. Second, use of six engines gives more capability of "engine out" operation.

The six engines will be in a circle, all swiveling in response to the control system. Just as in the eight-engine cluster of the big booster, if an engine fails those remaining will be able to use its propellant, and the control system will adjust the thrust vector appropriately.

More money is being pumped into the *LR-115* program, to prevent further loss of time. In the Fiscal Year 1961 supplemental recently approved by Congress, *Centaur* gets $16.2 million of the total $49 million granted to NASA. At the time of the request, the money was sought for vehicle development and system support. However, inasmuch as engine development has become a critical area, some of that money will go for engine work.

In addition, President Kennedy has asked Congress to increase the *Centaur* 1962 funding by $25.6 million—from $30.8 million to $56.4 million. Much of that additional money will go toward preventing further loss of time on the *LR-115*.

The schedule calling for a two-stage *Saturn* launching early in 1963 represents some slippage from the timetable announced last September at the Marshall Space Flight Center industry conference. At that time, three launchings—

*(Continued on page 18)*

# U.S. Presses Effort on Centaur

THE UNITED STATES is pumping more than $40 million of extra money into the *Centaur* program in an all-out effort to prevent further loss of time in developing the first American launch vehicle in the same league with the big Russian rockets.

The NASA-Convair *Centaur,* now scheduled for its first flight test in the fourth quarter of this year, will have an orbital payload capacity of 8500 lbs., and will be able to send 1500 lbs. on an interplanetary mission—compared with the 1400-lb. weight of this year's silent Soviet Venus probe.

Difficulty with the simultaneous start of the two LOX-liquid hydrogen engines of the *Centaur* upper stage has caused slippage of several months in the first launch—which at one time was scheduled for June. The problem has caused three explosions at the Pratt & Whitney engine development center in West Palm Beach, Fla.

The two engines must start within milliseconds of one another. Otherwise, hydrogen and oxygen soon build up to an explosive mixture in the closed chamber used for engine tests. A closed tunnel with a soft vacuum is used for the tests to simulate the *Centaur* engine problem of starting in space.

Ironically, the explosions would probably not take place in a true space environment because the hard vacuum of space would draw excess hydrogen and oxygen away before the condition could build up. However, the problem still must be solved to attain reliable engine performance.

The trouble in the *Centaur* engine program came to light very recently. Until late in 1960, officials of the National Aeronautics and Space Administration said, the engine program at Pratt & Whitney was proceeding very well.

In its request for 1961 supplemental budget funding for *Centaur,* NASA said $13.9 million was needed to speed vehicle development and $2.3 million was needed for system support. No money was sought for engine work. The engine problems developed subsequent to submission of the supplemental request. Liberal additional funding for the engine work is included in President Kennedy's recent request for an add-on of $25.6 million for *Centaur.*

In testimony before the House Appropriations Committee Feb. 16, Maj. Gen. Don R. Ostrander, director of NASA's launch vehicle programs, estimated that the total cost of *Centaur* development and launching 10 vehicles by 1963 would be from $170 to $180 million. The additional cost of the engine program will probably bring the figure to about $190 million.

Col. Donald H. Heaton, Ostrander's vehicle chief, said in an interview that Pratt & Whitney had several proposed solutions for the start difficulty. He predicted that the problem will be solved by mid-year.

The overall problem on the *Centaur* program has been that it pushed the state of technology every step of the way, he said. Previous experience in the use of supercold (—428 °F) liquid hydrogen as fuel was limited to research programs. And, to complicate matters, LOX and liquid hydrogen are not hypergolic. An ignition system is required.

"It is a pioneering development," Heaton says, "an effort to gain payload capacity and precision through efficiency—to gain the utmost out of an ICBM first stage."

The early phase of development progressed almost too smoothly, Heaton commented. There were few signs of trouble until the first attempt to fire the two engines last November.

The difficulty was not in ignition alone, he said. The *LR-115* bootstrap system ties everything together. Liquid hydrogen is used for regenerative cooling of the nozzle and the resulting gas drives the turbopumps. Electric spark ignition is used.

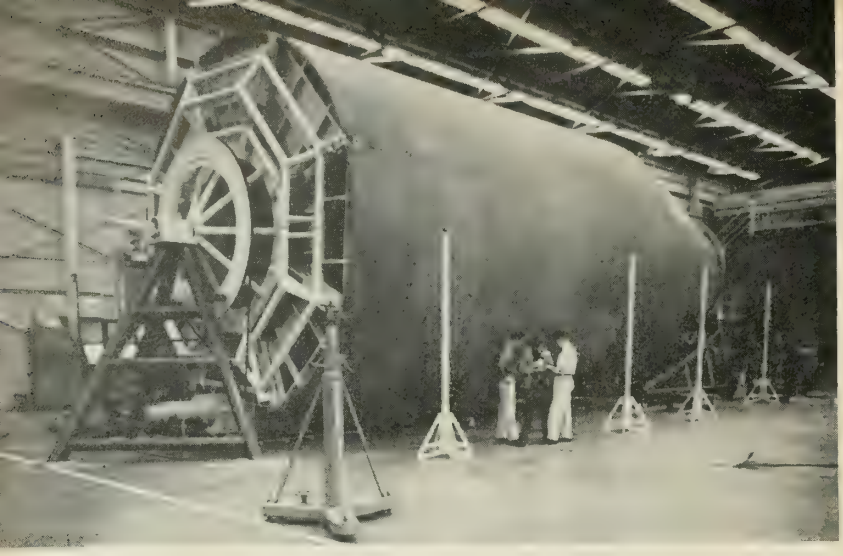
The problem, Heaton explained, is achieving buildup of pump speed, and thrust at exactly the proper rate to be in phase with the ignition. "This is no insuperable obstacle," he asserted, "but we have reached a point where we have to build up effort."

Pratt & Whitney has been authorized unlimited overtime since November, he reported. But additional money will speed the rate of testing.

From at least one point of view, the delay is not all black, the vehicle expert commented. The postponement of the launch makes it possible to do a more thorough job on other phases of the work. These include the study of heat transfer and foaming of liquid hydrogen under zero-G conditions. The supplemental budget funding includes money for four Aerobee rocket flights to investigate the problems. Zero-G tests with aircraft are in progress.

At the moment, NASA officials foresee no special problem in mating the *Centaur* stage to the modified *Atlas.* They note that the *Centaur* program, coming later than other *Atlas*-based vehicles has the benefit of experience gained in earlier programs. Also, the *Centaur* stage is the same diameter—10 ft. —as the *Atlas,* giving it an aerodynamically clean shape.

"We are meticulously holding to a policy of adequate design margins," says Cmdr. William Schubert, NASA chief of *Centaur*-class vehicles. "There will be no slicing of the baloney thin." ⌗



*DUMMY S-IV STAGE will fly atop Saturn booster in first three launches, beginning this summer. Configuration is changed from four LR-119 engines to six LR-115's.*

*(Continued from page 16)*

vehicles 2, 3 and 4—were set for 1962. No. 4 is to be the first with live second stage, if the first three launchings take place without major difficulty.

Five launchings now are planned for 1963: three with two live stages and two with all stages live. The last two are scheduled for the first half of 1964.

Richard B. Canright, chief of *Saturn* class vehicles in NASA's Office of Launch Vehicle Programs, says the delays to date have been of a managerial nature—"having everything at the right place at the right time, proved out."

• **Few headaches**—But Canright declared in an interview that the number of problems encountered to date has been far smaller than anticipated. "When we started in 1958," he remarked, "there were skeptics all over the country who predicted an eight-engine cluster would never work."

Very few problems were encountered in the two series of static tests with the prototype booster last spring and this winter, Canright said. In the first series, the only problem was with nitrogen used to pressurize the LOX at the test stand. It had a tendency to heat up the LOX and boil it away.

That headache disappeared in the second series, which pressurized LOX with gaseous oxygen, just as in the flight booster. In that series, there was a small problem of burbling at the bottom of the LOX tank as the supply approached exhaustion. The first solution attempted was a small standpipe, but that burbling continued around the standpipe opening. It was solved by putting a "hat" atop the the pipe. Canright said future flight boosters will probably eliminate the pipe, leaving the "hat" atop a drain at the bottom of the tank.

The only other difficulty that developed during the winter tests was a focusing of the sound from the test in some areas of Huntsville. Because of this situation, the fourth test had to be postponed about a week until the weather cleared. Study of the phenomenon revealed that temperature inversion creates a greater problem than low cloud ceiling.

It was expected that six to eight firings would be necessary in the winter series. However, only four were needed and the series was completed with a 110-sec. firing Feb. 14.

• **Barge cruise**—The prototype booster was then taken down from the stand and put aboard the barge Palaemon for its shakedown cruise. The first flight booster now has been erected in its place and static firings will begin in a few weeks. After completion of static tests, the booster will move over to the dynamic test stand, now near completion, for a final check on the mating with dummy upper stages.

Then will follow the long voyage aboard the Palaemon, down the Tennessee, Ohio and Mississippi rivers to the Gulf of Mexico, around the tip of Florida and up the coast to Cape Canaveral. The present schedule calls for launching from the Cape in late summer—probably September. The three stages are to be delivered to the Cape by Aug. 1.

Meanwhile, assembly of the *Saturn 2* booster is in progress at Huntsville. *Saturn 2*, also carrying dummy upper stages, is to be launched in the first quarter of calendar 1962. Assembly of the booster for *Saturn 3* is to begin in July. Assembly of the booster for *Saturn 4*, the first to carry a live second stage, will begin in December, 1961.

*Saturn 10*, to be launched in mid-1964, is listed as an operational prototype and the last vehicle in the development series. However, earlier *Saturns* probably will be available for carrying payloads on a space-available basis. If all goes well, Canright says, it may be possible to carry a payload of up to 10,000 lbs. on *Saturns 8* and *9*, in late 1963 and early 1964.

If the design of the *Apollo* three-man spacecraft is established enough by that time, there is some talk of carrying dummy *Apollos* on *Saturns 6* and *7*, which are to be launched in mid-1963.

It will be possible to achieve orbit with only two live stages, on flights 4 through 6. However, since the three flights are designed only to prove out the two-stage vehicle, it is not likely that all three will be programed for orbit.

Canright emphasized that failures are to be expected during the development program. "If we can get successes in 5 of 10 shots, it will be a pretty high ratio," he declared.

On the first three flights, Canright said designers will be watching for trouble in two areas: the effect of high-altitude winds on bending and twisting of the vehicle frame, and the effect of propellant leakage in flight. Leakage has caused no trouble on the ground.

When flights begin with live upper stages, the whole question of liquid hydrogen technology will come up. However, the problem will be simpler with the *S-IV* stage, the first to fly, because no coasting or attitude control is expected of it.

• **Guidance question mark**—NASA still has not resolved the questions about the *Saturn* guidance system, Canright reported. However, under current thinking, there is no plan to choose a manufacturer as prime guidance contractor during the research and development phase. Instead, the idea is to procure platforms and computers from different manufacturers and evaluate them on developmental flights.

At present, Canright said, four different combinations of computer and platform are under consideration. Within the next few weeks, Marshall SFC expects to reduce the number to two. One will be a modification of the *Jupiter* system, now supplied by Ford Instrument Co. The *Jupiter*-type system will ride as a passenger on *Saturn 3*. The other computing system will probably be tested on *Saturn 4*. The choice will be made after evaluating data from those two flights.

There is no resolution of the discussions about the relationship between *Saturn* guidance, to be developed by the Marshall Space Flight Center at Huntsville, Ala., and the guidance on lunar and interplanetary spacecraft, to be developed by Jet Propulsion Laboratory. However, top NASA officials have no serious objection to a limited amount of overlapping.

# Actual X-15 Altitude: 32 Miles Plus

***Record 'cliffhanger' trip by Walker also set mark for experience in weightless state; cabin pressure system and engine fail briefly; mysterious shaking***

REVISED NASA figures show that the altitude record-setting flight made by pilot Joe Walker in an *X-15* rocket plane reached 169,600 feet—4600 feet more than the preliminary figures indicated, and 20,000 feet better than called for by the flight program.

The new mark brings the world record to better than 32 miles above the earth. The flight also extended the known limits of man's experience of weightlessness to two minutes, doubling previous flights. Subsequent flights this spring will bring this to about five minutes in the *X-15*, and six minutes in the first *Mercury Redstone* astronaut launching.

Pilot Joe Walker described the latest *X-15* flight as a "real cliffhanger all the way." About seven minutes before *X-15* launch time, his cabin pressure system failed. A NASA spokesman said he was at low enough altitude so that his pressure suit system was not employed, and the cabin system was corrected.

After dropping from the B-52 mother ship, the *X-15*'s huge Thiokol XLR-99 engine suddenly faltered. After a few seconds interval—which Walker termed "like five hours"—he started it up again with no trouble.

Walker reached a top speed of 2756 mph recorded after 79 seconds burning at three-quarter throttle. He shut down the engine at 109,750 feet, and coasted to top altitude. His speed at top altitude was 2362 mph.

During descent, Walker noted that the ship was severely "buffeted" at about 80,000 feet. NASA officials were at loss to explain the phenomenon. The ship was undamaged and the shaking soon ceased.

The *X-15* flight took Joe Walker to about 99.97% above the earth's atmosphere. The *Mercury Redstone* shot, although planned to reach more than three times the *X-15* altitude of 32 miles, will carry the astronaut only 99.9999% above Earth's atmosphere. ❖



*NASA PILOT JOE WALKER smiles as he leaves X-15 after record-breaking ascent.*



**Said Gaspard de Coriolis:** *"A particle which is subject to no forces in a rotating coordinate system experiences a radial acceleration and a tangential acceleration."*

It was around 1840 that Coriolis discovered what has since become known as the Coriolis Effect. He noticed objects above the earth tend to rotate relative to the earth's rotation . . . to the right in the northern hemisphere, to the left in the southern.

The Coriolis Effect is in force in outer space, too. If a space vehicle is rotated in order to establish artificial gravity, the necessarily short radius of the rotation causes a Coriolis force. This creates orientation problems for a human occupant. To eliminate this difficulty, a scientist at Lockheed Missiles and Space Division conceived the idea of connecting the vehicle to an auxiliary fuel tank by a half-mile-long cable. Thus, if the whole system is then rotated at a reduced speed around its center of mass gravity, the longer radius greatly minimizes the Coriolis force. Right now—on the drawing boards at Lockheed—is an enormously advanced space vehicle system which utilizes this concept, in addition to many others.

Fortunately, natural laws are about the only restrictions which circumscribe scientists and engineers at Lockheed Missiles and Space Division. The climate in Sunnyvale and Palo Alto, on the San Francisco Peninsula, is close to perfection. The creative atmosphere—the opportunity to work on such important projects as the DISCOVERER and MIDAS satellites, the POLARIS FBM, or even more advanced concepts such as the space system cited above—is the dream of the creative engineer.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-11C, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

***Lockheed*** / **MISSILES AND SPACE DIVISION**

***Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Program***

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

# Technical Countdown

## ELECTRONICS

### Solar-driven Laser in the Works

A contract to develop and build a prototype sun-powered laser system has been awarded American Optical Co. by Air Force, WADD. Reportedly the system is for eventual use in long-range space vehicles for optical communications. AO also will build the solar-radiation collector for the working model.

### 'Gridded' Solar Cells More Efficient

Production-run solar cells with efficiencies up to 13% have been put on the market by International Rectifier Corp. Improvement is due to better collection of current by use of secondary collector strips "gridded" over the active area of the cell.

### EIA Forms Microminiature Components Group

A microminiature components advisory committee has been set up within Electronic Industries Association. The group will advise on user recommendations for microminiature components for all applications. Its function was previously limited to computer applications.

### Better R-f Connectors Aim of NBS

Bureau of Standards is sponsoring a meeting aimed at reducing errors in precise measurements due to r-f connector "uncertainties." It's hoped that the one-day meeting (June 29, Boulder Laboratories) will lead to standardization of a minimum number of connectors for use in laboratories and incorporation in precision instruments.

### Thermionic Reactor APU Facility Started

General Electric's Atomic Products Division, Palo Alto, Calif., has established a project for the design of small nuclear conversion power units for space vehicles. Known as STAR (for Space Thermionic Auxiliary Reactor), the project is totally company-sponsored. GE says it will merely work toward design of such an electrical system, not build a prototype.

## HYDRONAUTICS

### Vaporborne Missiles Studied

Using a gaseous envelope around underwater missiles may double their speed, says Convair. Scientists at the division's San Diego facility so far have proved that much of the skin-friction drag of hydrodynamic bodies can be eliminated by such a vapor covering. It has been created in the lab by heating missile skins and by using body surfaces which react chemically with water.

## SUPPORT EQUIPMENT

### Linac Spots Fuel Flaws Faster, Deeper

Radiographs, employed to detect flaws in *Polaris* IRBM solid-fuel propellants, can now be made through the entire 5-foot thickness of the missile in 2 minutes, using a new 10-million-volt linear accelerator. Built by Varian for the Naval Ammunition Depot, Concord, Calif., the instrument replaces 2-million-volt X-ray units that required 15 minutes exposure time and penetrated only 2½ feet (film was placed inside the rocket-engine bore). The new linac can detect flaws of a few hundredths inch diameter, Varian reports, and cracks 1 in. by 0.005 in. have been located through 4 feet of propellant.

### Antenna Loses Reflector

A 60-ft. antenna at Lincoln Lab's Millstone Hill banged into its base and separated the dish from its mount. Described only as part of "radar and communications facilities", the antenna was reportedly for use with Project *Needles*—the proposed orbiting belts of metal fibers for scatter communications (M/R, Sept. 19, 1960).

### Venus Probe Uses Simple Telemetry

Russia's recent Venus probe apparently carried an unsophisticated telemetering system with only four data channels: temperature, magnetic field intensity, meteorite density, cosmic radiation. A drawing of the 922.8-mc system indicates that a simple mechanical commutator was used.

### Lightweight Minuteman Hoist

Emplacement hoist developed by Western Gear for *Minuteman* is required to meet a 38-ton operating load and 50-ton static load, without weighing more than 1875 lbs. itself.

## ADVANCED MATERIALS

### Exotic Bearings Operate at 1000°F

SKF Industries has been running experimental bearings at 1000°F and higher, using powdered lubricants fed in by a stream of nitrogen gas. Bearings and seats are fabricated on production equipment from carbides, ceramics and other specially developed heat-resisting alloys.

### Space Surface Effects Surveyed

The mechanical behavior of structural materials subjected to vacuums of the order $10^{-10}$ mm Hg will be investigated by National Research Corp. under a $49,520 Air Force contract. Pressure range is equivalent to altitudes beyond the 500-mile mark.

### USSR Studies Electron-Beam Zone Refining

Single crystals of molybdenum, tantulum, rhenium and other refractory metals are being zone-refined with a laboratory electron beam unit, says Russian metallurgist A. N. Nesmeyanov, president of the Soviet Academy of Sciences. He also reports that a physico-chemical theory of designing metal alloys has been developed, making it possible to obtain alloys with predetermined properties.

# Tartar's Director Is Outstanding In Field

by Hal Gettings

A NEW APPROACH to missile director design has paid off in increased accuracy, reliability, and performance for the Navy's *Tartar* ship-launched missile.

The *Tartar's* unique Mk73 director, built by General Electric Ordnance Dept., uses a gearless power drive in combination with a high-precision servo system to provide speeds, accuracies, and operating smoothness previously unattainable in such systems.

The *Tartar* is guided by a radar beam from the director which locks on and tracks the target. The director is thus a critical element in the overall weapon system; it must be able to track supersonic aircraft or missile targets at high speed with pinpoint accuracy.

The Mk73 is part of the complete system that guides the supersonic *Tartar* to its target. It serves as the mount for the AN/SPG-51 radar antenna and part of its electronics.

In operation, the system automatically follows a complex routine to acquire a target and guide the missile to the kill:

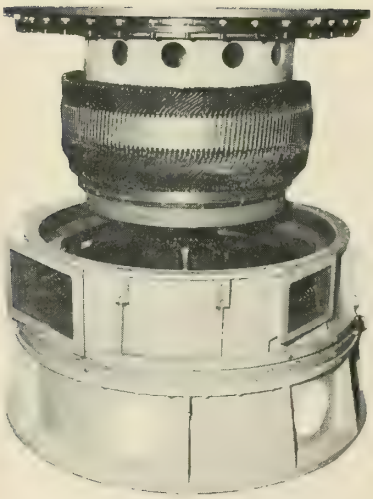
—Weapon detection equipment designates the target to the computer, radar and director, and the latter two synchronize to the signal.

—Computer generates a search pattern which director and radar follow until target is acquired.

—Radar and director commence tracking.

—Computer generates fire-control data and transmits gun and missile launcher position orders; also provides missile-seeker angle data.

—Missile is launched and follows radar beam to target.



*GEARLESS POWER DRIVE eliminates all power gearing, with its problems of backlash, resonance, and inertia. Stator of train motor (bottom) is part of director base; rotor is integral part of upper rotating portion.*

• **No power gearing**—Principal unique feature of the Mk73 design is the gearless power drive, developed as an answer to the problems of gearing backlash, resonance, and inertia. GE engineers felt the real solution to the problem was not higher quality gears and precision gear trains, but the elimination of power gearing itself.

In the Mk73, the stator of the train (azimuth) motor is a part of the base of the director; the rotor is an integral part of the upper, rotating portion of the director. A similar system is used for the elevation power drive.

GE says that in addition to eliminating gear trains the gearless power drive provides unparalleled low-speed smoothness, high servo loop gains, mechanical simplicity, low power consumption, and a compact contour. The precision positioning obtainable with the device is described as unexcelled in the field.

• **Advanced servo system**—To take full advantage of the gearless drive, it was necessary to create an advanced servo system for the Mk73. This power drive servo system, designed for extremely high precision, uses gyro-generated rate response to determine error signal. An angular accelerometer is also attached to the load to provide velocity-damping degenerative feedback.

• **Rigid lightweight structure**—Because of the high gain characteristics of the servo system, it was necessary to eliminate all factors which could contribute to servo-loop oscillation. Sensitivity of the system to low-frequency vibration was particularly critical, and the reinforcement of any such vibration had to be eliminated.

To solve this problem, all structural members were designed to have resonant natural frequencies in excess of 20 cps. This was achieved through an exacting stress analysis and the integration of all motors into the structure. In the case of the direct-drive train motor, the rotor is part of the rotating structure and the stator yoke forms the major portion of the main load-supporting base, eliminating the weight of gear boxes and bull gears.

Design requirements of rigidity and lightness also presented a fabrication problem. New techniques of welding had to be devised to prevent warping of the thin-wall fabrications. Many components had to be cast to assure the proper strength. And the problem of mating aluminum with steel parts had to be solved.

The director was designed for 0.5 mil accuracy in the alignment between principal axes. Precise machining produced parallelism and flatness tolerances of 0.001 in. on surfaces larger than 40 in.

GE says the resulting Mk73 design exceeds all requirements in its ability to withstand adverse loading and fluctuating axial torque. The director can sustain 100-knot winds and blast loading equivalent to 50,000 lbs. of force on the radar reflector.

• **Special gear and bearing design**—Although the director uses no power gearing, precision instrument gearing is required for data transmission. The initial data take-off is from a ring gear operating at load speed. This gear, for train, has maximum tooth-to-tooth error of 0.0003 in. and total composite

rror of 0.0008 in. with a pitch diameter f 37.200 in.

The train bearing is designed to carry ll loads between rotating and stationary arts of the director. A specially designed 4-point contact-type bearing was hosen to carry vertical, radial, and ver-turning loads. This bearing proved o be extremely smooth in operation nd offered a minimum amount of friction. The bearing races are held concentric with the mounting surfaces within 0.003 in., with runout no greater han 0.0005 in. The bearing diameter, approximately three feet, must withstand 50,000 lbs. thrust and 250,000 ft-bs. of over-turning moment.

• **Braking and buffering**—Elimination of power gearing in the Mk73 required a means of load-speed braking the rotational motion of the director in the event of no-load operation. To meet this requirement, an adaptation of an aircraft landing brake, operating at load speed and capable of holding against 2000 ft.-lbs. of torque, was used. The system is hydraulically released and spring-set with quick response time for fail-safe operation.

Since director train rotation is unlimited, several devices and circuits were designed to prevent runaway without damage to the equipment. A buffer system was developed to restrain the antenna system under runaway conditions which require dissipation of up to 300 slug-ft.$^2$ of inertia.

• **Safety, cooling and packaging**—Potential radio-frequency radiation hazards to personnel dictated that the director be unmanned. However, since operating technicians must be able to see from the vantage point of the director, it was necessary to install a remotely controlled TV camera in the director.

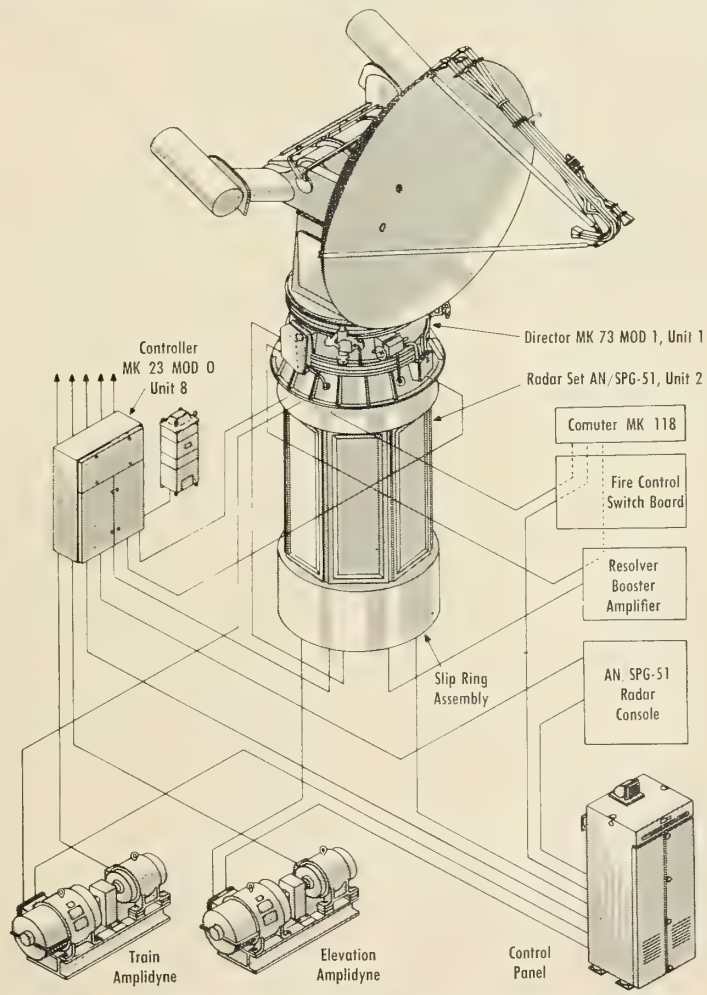
Air from the ship's ventilating system is ducted through the director to cool motors, wave-guides and other heat-producing devices within the unit.

Throughout the development and design of the Mk73, a primary consideration that the entire unit be kept as compact as possible. One of the most difficult problems was in packaging the wave guides so that they fitted in the director without impairment of electronic characteristics.

Although work was started on the director concurrently with all the other major subsystems, the Mk73 was completed and operational before any of the other components. ⌘



*MISSILE DESTROYER ADAMS (DDG-2) was first Navy ship to be armed with operational surface-to-air Tartar. Mk73 directors (circle) track target and furnish radar beam which guides missile to interception.*




*GUIDED MISSILE DIRECTOR Mk73 is unmanned, amplidyne-controlled, two-axis unit which carries radar antenna and portion of electronics. Radar line-of-sight can be rotated continuously in horizontal (train) and from —30 to +85 degrees in vertical (elevation) plane.*

# Kennedy Seeks Record Spending f

## *Administration program would nearly double last year's budget funding; good prospects seen for compromise of Senate, House legislation*

PRESIDENT KENNEDY is pressing Congress for unprecedented funds for oceanography because "our very survival" could be at stake.

Calling for a national program, the President has asked Capitol Hill to provide $100 million for oceanography —nearly double the amount in last year's budget, $23 million more than former President' Eisenhower's Fiscal Year 1962 request, and by far the largest sum proposed for this purpose in the nation's history.

In a special message sent to Congress on March 29, Kennedy declared that "Knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge upon it."

The Chief Executive said that so far the U.S. has neglected oceanography, even though its study would yield important military advantages. "We do not have adequate charts of more than one or two percent of the oceans," he reminded Congress.

A major oceanographic bill is pending in both the Senate and the House, each measure authorizing a national program.

A bill offered by Sen. Warren G. Magnuson (D-Wash.), chairman of the Senate Committee on Interstate and Foreign Commerce, calls for a 10-year program during which about $600 million would be spent on oceanography. His committee is currently holding hearings on it. Last year, a similar bill by Magnuson passed the Senate unanimously, but its counterpart languished in the House.

In the House, the Chairman of the Committee on Merchant Marine and Fisheries, Rep. George Miller (D-Calif.), told MISSILES AND ROCKETS he is hopeful that hearings on his bill will be held before the end of the month.

"I think the chances of passing a compromise bill during the present session of Congress are very good," Miller said. He added that his bill and Magnuson's do not differ greatly, and both are in line with Kennedy's message.

A three-part program comprises the Administration's recommendations: (1) Substantial early investments for building and operating ship and shore facilities for oceanographic research and surveys. (2) Developing new instruments for charting the seas and gathering data. (3) Training new scientific manpower.

To do this, the Administration is calling for the coordinated efforts of many federal agencies. In fact, enabling legislation to let the Coast Guard do oceanographic research—which statutes now prevent its doing—is in each Congressional bill and in the President's message.

• **Ship construction**—In the Administration program for 1962, $37 million is included for ship construction, an increase of $23 million over 1961. This money will provide for 10 oceanographic vessels, only two of which will be replacing existing ships.

The success of the national oceanographic program hinges heavily on the construction of modern, specially designed vessels. The country's present oceanographic fleet has only 27 research ships and 17 survey vessels. Many of these are over 30 years old, and all but two of them were built before the end of World War II. Also, only two of these ships were specifically designed for research purposes.

• **Facilities and data center**—Shore facilities are critically needed to provide the laboratory space to analyze oceanographic data and to train new oceanographers. A rule-of-thumb figure is that oceanographic research takes about five scientists and technicians ashore to match one aboard ship.

Thus for 1962, the Administration is requesting $10 million for laboratories and wharfside facilities. This is more than a fivefold increase over 1961.

One deficiency filled by Congress last year was establishing the National Oceanographic Data Center, which will begin its first full year of operation in 1962. This Center will act as a clearing house to the scientific community for oceanographic data collected throughout the world. In 1962, a half-million dollars is being budgeted for this work.

• **Research money**—To conduct research on a coordinated and efficient basis is the chief purpose of the national oceanographic effort. For this reason the proposed budget includes $41 million for basic and applied research. This is almost a one-third increase over the 1961 level.

This money will be used to study problems such as sound propogation in water, effects of ocean conditions on movement of ships, and better ways of weather forecasting. Eventually, this work may lead to maps of "weather within the sea" just as we have maps of weather in our atmosphere.

### *National Oceanographic Program Budget*

**Summary by Federal Agency**

*(thousands of dollars)*

| | Actual FY 1960 | Estimated FY 1961 | Estimated FY 1962 |
|---|---|---|---|
| Defense | 23,003 | 22,729 | 32,837 |
| Commerce | 6,202 | 11,389 | 24,691 |
| Interior | 6,723 | 8,704 | 15,472 |
| National Science Foundation | 7,833 | 9,148 | 19,607 |
| Atomic Energy Commission | 1,708 | 2,207 | 3,619 |
| Health, Education & Welfare | 340 | 698 | 1,150 |
| Treasury | 134 | 134 | 134 |
| TOTALS | 45,943 | 55,009 | 97,510 |

**Summary by Function**

*(thousands of dollars)*

| | Actual FY 1960 | Estimated FY 1961 | Estimated FY 1962 |
|---|---|---|---|
| Research | 26,577 | 31,883 | 40,947 |
| Ship Construction | 13,533 | 13,975 | 37,050 |
| Surveys | 4,168 | 7,117 | 8,725 |
| Facilities | 1,370 | 1,768 | 10,422 |
| Data Center | 295 | 266 | 510 |
| TOTALS | 45,943 | 55,009 | 97,501 |

# eanography

by William Beller

Knowing the currents that run in he sea is highly important for the urface and submarine fleet. A 60-knot essel running in a 6-knot current vould have the same advantage as a 500-knot aircraft running in a 60-knot et stream.

Extremely important to the research program is the development of oceanographic research tools. So vital does this work appear that Magnuson in his bill actually lists some of those that most direly need developing. He is calling for bathyscaphs and other manned submersibles, instrumented marine towers and deep ocean buoys, wave gages, acoustical equipment and telemetering devices, and current meters.

He is also asking for direct-density, turbulence and radioactivity measuring devices, biological sampling instruments and equipment, precision salinometers and echo sounders, magnetometers, and deep-sea underwater cameras.

• **Mapping the seas**—The Administration is calling for world-wide surveys of the oceans, their properties, their contents and boundaries—in order to make charts and maps for research and for defense and commerce. To help do this, Kennedy is budgeting money to allow the Coast and Geodetic Survey —which Congress last year permitted to go beyond the three-mile limit for oceanographic research—to extend the operating season of its ships, thereby making longer use of the limited ship resources.




*MAP OF ARCTIC FLOOR derived in part from transits by U.S. nuclear submarines.*

• **Defense applications**—The naval officer is again and again confronted with transient and subtle changes in the ocean depths which always affect and often control the success of the service's weapons systems. Yet since World War II there has been no effort to improve research ships in this country. In the meantime, the Soviet Union has been pushing ahead in building oceanographic ships, making oceanographic studies and training their oceanographers.

"Only last summer that country had seven large research ships conducting intensive studies of the Gulf Stream all along our Atlantic coast," Magnuson says. He pointed out that during that time we had only three small research ships working briefly in the vicinity of Bermuda.

Every fishing vessel and trawler the Soviet sends out has its complement of highly trained oceanographers. This was brought out during the exchange of data stemming from International Geophysical Year research, and from conversations of our scientists with those from Russia.

Last year, the Soviet had research ships working in the Bering Sea, along the Aleutians and the Gulf of Alaska. Also during that period, it launched four new research ships, at least two of which had more than 3600 tons displacement. On the other hand, last year the U.S. had contracts for construction of only two research ships of about 1500 tons displacement to be completed in 1962.

The last and only ship outfitted for oceanographic research for the U.S. is the 298-ton *Atlantis*, built in 1931. All the other research ships are converted surplus naval auxiliary vessels, or aging ex-schooners, purse seiners, tugs, tuna clippers or similar craft.

Happily, as a result of the transits of the Arctic Ocean by nuclear submarines, the U.S. has advanced knowledge about the characteristics of that area.

Until the mid-40's, the general idea was that the floor of the Arctic Ocean was an abyssal plane unbroken from coast to coast and averaging about 2000 fathoms in depth. Later work by the U.S. and the Soviets shows these conclusions to be grossly in error.

One of the biggest boons to oceanography that a Magnuson-type bill can give is the impetus for planning scientific work on a long-term basis. Oceanographic research organizations continuously complain that the usual "on-again off-again" type funding they receive does not easily lend itself to serious work. ⁂

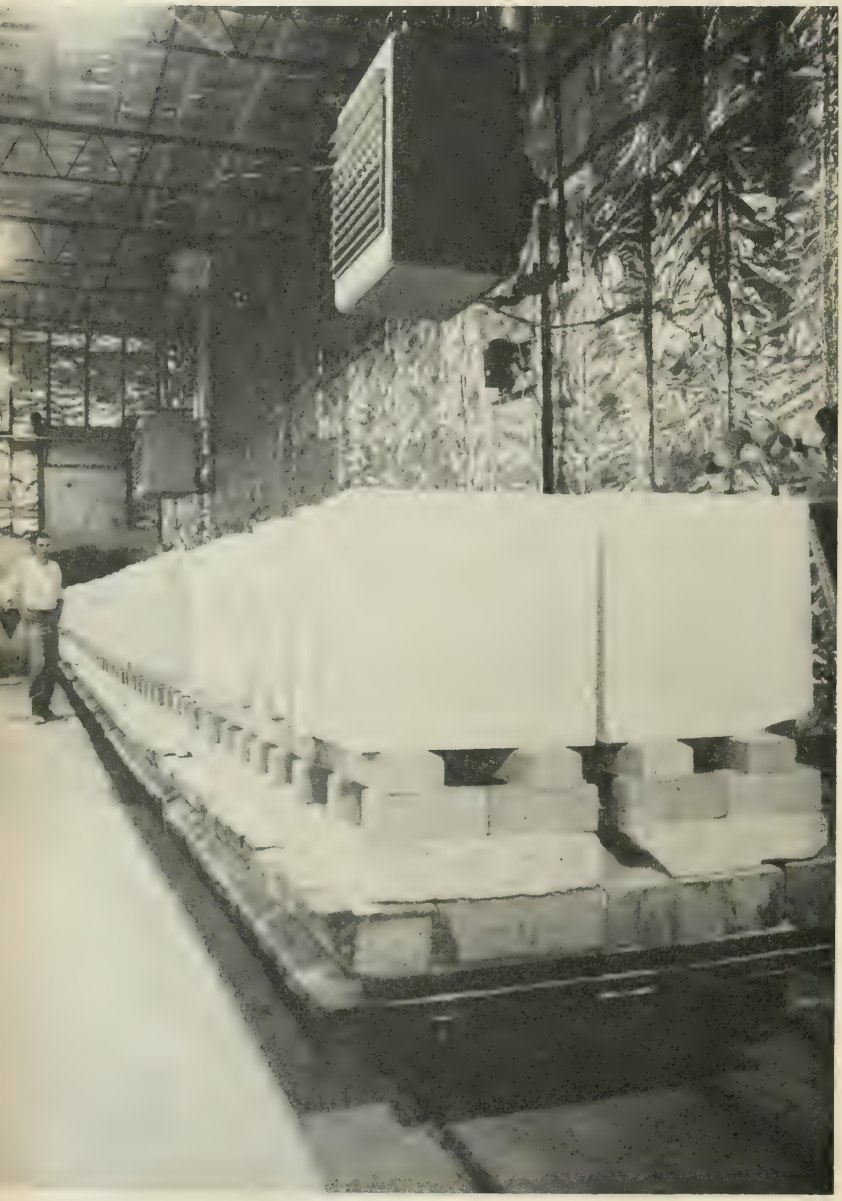
**Bill S. 901,** *introduced by Sen. Warren G. Magnuson (D-Wash.) on Feb. 9, 1961, calls for developing new and improved vehicles and instruments for ocean research and exploration. These may include, but are not limited to, the following:*

*Bathyscaphs, mesoscaphs, self-propelled deep-sea data collecting vehicles, and other manned and unmanned submersibles, and submarines converted for scientific use, seismic equipment, turbulence measuring devices, oceanographic sound velocity meters, precision echo sounders, acoustic telemetering devices, navigation location transponders, audiovisual surveillance systems to monitor sources of biological noises in the ocean, submarine oceanographic plankton samplers, hydrophotometers, fixed coastal acoustical-oceanographic monitoring systems, marine geophysical gravity meters, marine geophysical electron resonance magnetometers, shipboard wave meters and dye detector probes, marine geophysical remote sensing and recording systems, moored oceanic ambient noise monitoring buoys, expendable oceanographic sensor systems, oceanographic sonic and radio frequency marine tags for monitoring marine fishes and mammals, improved midwater trawls, oceanographic shipboard synoptic systems for use on weather ships, marine radioactive water samplers, shipboard gamma ray detectors, marine geophysical underwater cameras, geophysical sea floor television systems, sea floor sediment samplers and analyzers, sea floor dredge winches, and other such instruments, devices and systems as may be useful in studies of the current structure of the ocean, oceanic temperatures, bottom topography, sediments, heat flow through the ocean bottom, sound transmission and velocities, ambient noise, biological activity and specimens, water samples for salinities, phosphates, oxygen, nitrogen, and other chemical or elemental components of the oceans, and for recording and communications of oceanographic data.*

# Glasrock Applications Described

***Uses of highly shock-resistant ceramic family have been studied at Georgia Tech since '56***

**by John F. Judge**



*BLOCKS OF GLASROCK FOAM roll out of the curing kilns. These blocks are a major constituent of massive brazing and stretch forming fixtures.*

ATLANTA—A family of ceramic materials characterized by extraordinary shock resistance and ease of fabricability is stirring interest throughout the missile/space industry.

Produced by Glasrock Products Inc., the material has applications ranging from ablative nose cones to the massive tooling and brazing fixtures required to shape tough Space Age metals.

The ceramic starts with 99.9% pure silica sand. A unique melting process developed by John North, president of Glasrock, converts this into lumps of fused quartz. The quartz is then ground or crushed to obtain "Glasgrain" and "Glasflour," the basic material of the family.

From this comes "Masrock," dense aggregate castings with smooth faces; "Shelrock," dense slip castings with smooth faces; "Glasrock Foam," light porous blocks; and "Glasrock" Cement.

The firm has expanded twice in as many years and is currently operating at top capacity to meet a rapidly increasing market.

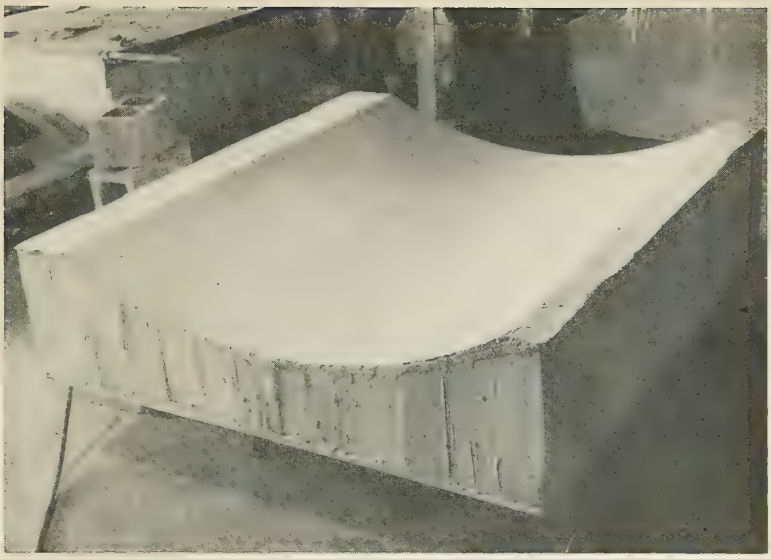
• **Unlimited potential**—The Ceramics Branch of the Georgia Institute of Technology has been exploring the applications of Glasrock since 1956. J. D. Walton, Branch Chief, says "the potential uses of this material are essentially limitless, including such fields as nuclear, chemical, electrical and optical as well as ceramic and aircraft or missile industries."

Fused silica is a well-known substance. But Glasrock, while the same basic material, does not have the properties of clear fused silica. The material is crushed into fine particles and then cemented into shape. These shapes are formed at room temperature—not at 3100°F, as is clear fused silica.

The effect of pulverizing is illustrated by the difference in thermal conductivity. Clear fused silica shows a rapid rise above 300°F while slip-cast fused silica is a good insulator up to 2000°F.

N. E. Poulas, Assistant Head of Georgia Tech's Ceramics Branch, at

# mitless'



*TYPICAL BRAZING FIXTURE illustrates one application of foamed silica blocks. Dimensional stability and thermal shock resistance are excellent.*

tributes this difference to the transmission of radiant energy in the clear form and the diffusion of this energy by the particulate form. This factor is evident in the use of slip-cast silica reflectors for clear fused silica radiant heating lamps.

The low thermal expansion of Glasrock gives it high thermal shock resistance. A piece of Glasrock will remain intact through numerous cycles of immersion in molten iron with alternate cooling to near-room temperatures by water, or immersion in liquid nitrogen from 2000°F.

This characteristic is due to the many fine bonded particles which provide areas of thermal stress relief.

The bonded Glasrock is weaker than solid glass cast in the fused state. Glasrock normally has a modulus of rupture or flexural strength from 300 psi to 4000 psi. The electrical properties are essentially the same as fused glass, with allowances for porosity.

Chemical resistance has not yet been fully checked out. The firm recommends the material in dense compositions for trial in the same areas as silica glass—with the expectation that chemical soaking into the pores will be somewhat more active against individual grains than solid glass. This is due to the greater area exposed. Generally it is highly resistant to chemicals on the acid side and fair for alkalies.

The melting point of Glasrock without binders is slightly over 3100°F. It is quite viscous above this point. Pieces of considerable size can be fused into stronger and practically impermeable bodies while supporting themselves against appreciable sagging.

• **Devitrification**—In refractory areas, the material has some special characteristics. Handbooks maintain that above 2000°F under prolonged or cyclic heating, fused silica will devitrify or crystallize into cristobalite, another form of silica. In an attempt to define the cycle effect, GPI engineers poured cast iron repeatedly into the same Glasrock mold, allowing the casting to remain there until it solidified. After repeated trials involving dozens of cycles, no devitrification was found. The same effect was checked with a laboratory furnace. It appears that if one cycle will not start the crystallization, then neither will repeated cycles under the same conditions.

One side of a Glasrock block was exposed to furnace temperatures while the other remained at room temperature. In this case, the hot side devitrified to near the point where the expected temperature reached 2000°F. The devitrified portions showed check cracking or crazing which commenced well after the sample had lost its color from the heat. The crystallized portion bonded firmly to the unaffected areas. This has also proved out under vibration conditions.

In the containment of ferrous metals, cristobalite has practically the same volume as silica glass above 1200°F. If the vessel pipe or valve is kept hot, devitrification is no problem. If cracking does occur because of cooling, it is necessary to preheat to 400°-500°F, which closes most of the cracks before the molten metal is poured.

General Electric's Missile and Space Vehicle Department is looking at Glasrock as part of the whole range of $SiO_2$ compounds from a laboratory standpoint. The effect of ablation tests on various structures and textures of this type of material are under study. GE scientists have doped it to change the emissivity.

MSVD specialists find Glasrock's fabrication qualities attractive. It can easily be slip-cast into intricate shapes at room temperatures. They find the material excellent for wind-tunnel models because of this easy fabricability.

• **Nuclear applications**—Glasrock is being actively investigated for certain reactor uses because of its thermal shock, chemical inertness and low-neutron-capture cross-section properties. In addition, radiation is actually beneficial —crystalline substances tend to vitrify under prolonged exposure. Glasrock materials are already completely vitrified.

All of these qualities are coupled with a product form that can be easily engineered. Complex one-piece heat exchangers have been fabricated.

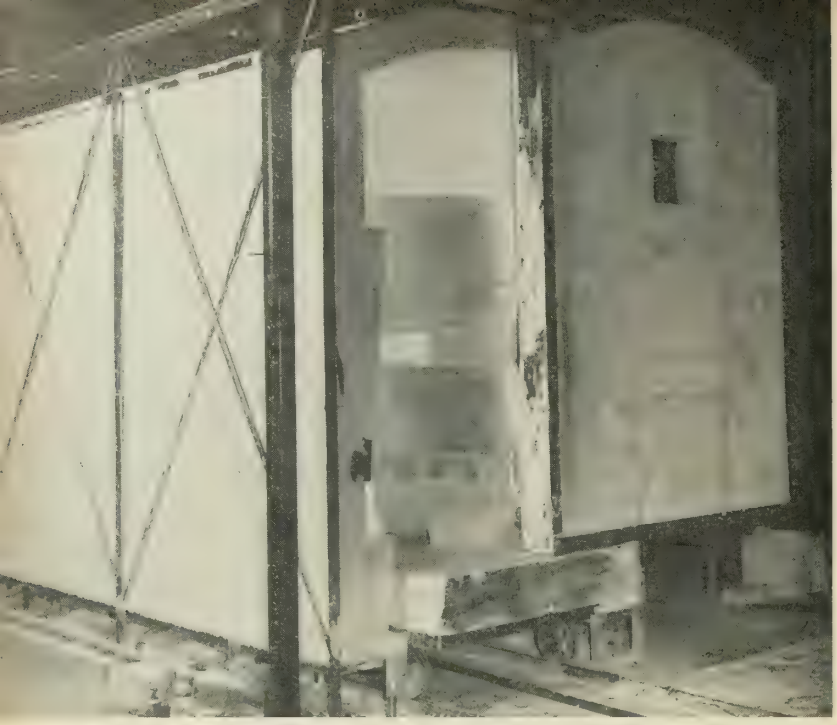
Probably the biggest single application of the material is in the fabrication of super alloys such as titanium and stainless steel. Within this general area are brazing fixture uses for honeycomb panels.

Convair-Fort Worth interest in Glasrock materials centers around stretch forms and brazing applications. Test tools have been evaluated to the point where production tools are being fabricated.

Convair is currently using gas-heated Meehanite stretch forms for production of titanium skins. These tools are expensive, requiring long lead times and much hand finishing to reach final configurations. Tool surface temperatures are not easily controlled.

A Glasrock tool, integrally heated by nichrome wire embedded in its face, can be fabricated at approximately ¼ the cost and, more important, tool surface temperatures can be controlled to within ±20°F.

• **Tough-metal forming**—Convair's fabrication technique begins with a female plaster mold, prepared to final configuration. A spacer sheet of rubber or epoxy is placed against the face of



*LOW "K" FACTOR coupled with the high reflectivity of the foamed blocks used in construction of this inexpensive furnace makes the walls just warm to the touch—while containing temperatures up to 2000°F.*

the plaster and a Glasrock cement-Glasfoam backup is built, filling the entire plaster pattern. The backup is allowed to cure until "green strength" is sufficient to allow the pulling of the pattern and spacer blanket.

Location holes for resistance heater wires are drilled in Dike boards which are cemented and pinned to the back-up. "Dummy" wires, oversize to actual heater wires and treated with a parting agent, are strung across the back-up and tied to the Dike boards.

The entire back-up is then repositioned in the original plaster pattern and Glasrock cement is cast in the void area created by removing the spacer. The casting is allowed to cure until the pattern can be removed. "Dummy" wires are pulled, a steel plate is attached to the casting as a base and the tool is ready for wiring.

Convair cites as advantages the relatively short fabrication time, the need for only semi-skilled personnel, the ability to cast to final configuration with no grinding or hand finishing, the absence of any need for lengthy high-temperature cure, the easily controlled surface temperatures and complete freedom from thermal shock effects.

Among the disadvantages are the relatively high cost of Glasrock materials, the fact that their poor impact resistance and low flexural strengths create a need for caution in handling and storage, and a tendency of the surface to be abrasive.

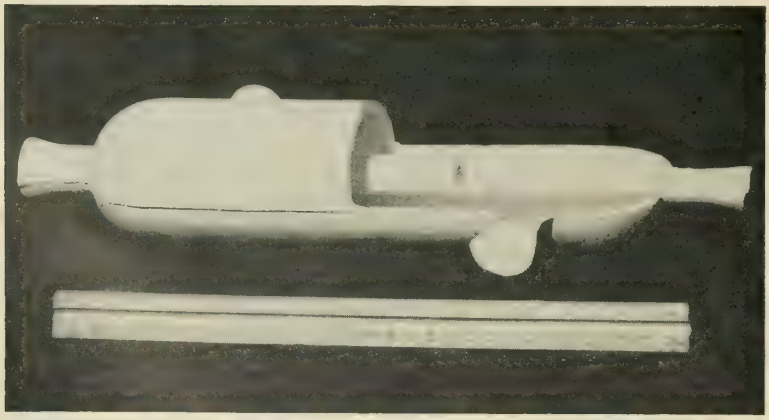
G. P. I. maintains that their ceramic compares favorably in cost with other tooling materials such as tooling plastic, Meehanite and graphite. The time and labor savings are above and beyond this.

Brazing fixtures at Convair are quite similar, except that these tools are not integrally heated. Cooling provisions are included. These tools are supported by steel structures which take most of the load.

Convair is evaluating both the two-member and one-member die concept of brazing. Male and female ceramic members are required for the former, with both members demanding extensive cooling facilities. Using only one ceramic tool, combined with a metal pressure bag built to the proper configuration, cuts tooling costs almost in half.

Through Glasrock, Convair eliminates the need for brazing furnaces—in addition to the advantages cited for the stretch forming process. On the other hand, Convair reports, the disadvantages are generally the same—including the high cost of fabricating the steel structure.

Almost all major missile/space firms are involved with Glasrock to some extent. North American Aviation has flatly stated that the B-70 could not be built without such a material. ■



*FUSED SILICA HEAT EXCHANGER was formed by slip casting methods at Georgia Tech. The device grew out of a U.S. Bureau of Mines fabrication study.*

## Cost Cuts Expected from 100% Tungsten Castings

PURE TUNGSTEN is being melted and successfully cast into hollow-ring shapes by Oregon Metallurgical Corp., Albany, Ore. The development is expected to reduce the cost of production parts of the metal.

Ormet uses a cold crucible, skull-melting vacuum-arc furnace. The copper crucible is kept cool with water. The furnace is charged with 40,000 amps of power at about 40 volts d-c.

The castings are produced by centrifugal process in hollow-ring shapes up to 10 in. across and weighing up to 220 lbs. The pure metal rings have a finer grain structure than was heretofore attainable with arc-cast ingots. The melt is achieved in five minutes and pour must be made within four seconds.

Tungsten melts at 6170°F, but the exact temperature of the melt just prior to pour is not known.

One immediate advantage is that the expensive machining of tungsten ingots by rough hogging out the surplus metal may be eliminated. This method usually resulted in three 30-lb. products from a 1000-lb. ingot. ■

# A Low-cost B-58 Defense Simulator

***Air Force says Reflectone-built system, costing only one-hundredth as much as the aircraft itself, may be the most complete ever developed; sharp cut in training time is likely benefit***

A REALISTIC SIMULATOR developed for Defense System Operators in SAC's B-58 supersonic bombers will save considerable time and money during training—without tying up much-needed aircraft and crews.

Designed and built by Reflectone Electronics, Inc., for the Air Force's Strategic Air Command, the first training complex is now in operation at Carswell AFB, Fort Worth, Texas. Reflectone reports that acceptance tests have just been completed on the first of four such systems being built under a current contract to Convair Division of General Dynamics.

Designated AN/ASQ-T1, the trainer includes an exact replica of the defense system station in the Mach 2 bomber. It provides flexibly programed enemy electronic detection as well as aircraft or missile target-generating stimuli, and has the ability to evaluate operator performance. An Air Force spokesman says the system is believed to be the most comprehensive ever built.

A complete system, according to Reflectone, costs one-hundredth the price of a B-58.

Initially, the simulator will be used 12 hours a day for orientation of new B-58 crew-members and transitional training. Eventual programs call for three intensive 6-hour proficiency training missions daily.

• **Operator functions**—The Defense System Operator (DSO) is responsible for protecting his aircraft from enemy detection and attack so that it can complete its assigned mission. Since the pilot and navigator of the B-58 are otherwise occupied, the DSO must monitor for tracking and possible attack. It is his task to command evasive actions or take necessary electronic countermeasures.

Use of the DSO simulator is expected to compress radically the time required for training B-58 crews in critical skills to peak proficiency. It can be operated independently or, for maximum value, interconnected with navigator and pilot trainers for coordinated aircrew instruction.

Interconnect inputs to the DSO trainer provide information which would be simulated normally during independent operation. These data include true airspeed, altitude, angle of attack, true heading, aircraft position (latitude and longitude), bailout signals, station beacon, and jamming information.

In turn, the trainer subsystem provides the flight simulator with certain signals and with commands for evasive action. Changing data received by the DSO station continuously affect the training problem.

System computers constantly adjust target attack or maneuver patterns, as well as positions of simulated ground-based radars, to coincide with the input positional data. The intercom system, tape recording, and certain training problem control functions also can be interconnected.

• **Composite design**—The system includes in one unit an isolated trainee station, duplicating the third crew station of a B-58, an instructor's station, recording equipment and associated instrumentation.

The system simulates ground radars and radar-equipped aircraft or missile targets. The student operator receives visual- and audible-alarm warnings of attack or detection; he must select evasive, ECM, or chaff techniques to combat the enemy threat.

Reflectone's simulator was developed to contain all the actual operating equipment necessary to train a DSO. Because of the critical nature and speed of skills required for B-58 operation, composite design was mandatory for proper training environment.

Training must be provided in the tactical use of active and passive defense systems, including fire control and ECM gear. Faithful duplication of operational environment also demands operator orientation in use of the canopy, ejection seat, oxygen and communications systems, fuse control and fuel management functions.

Visual stimuli such as lighting and fire control system display are simulated, along with aural stimuli such as flight sounds, radar warning signals and intercom.

• **Flexible programing**—A highlight of system design, Reflectone feels, is the flexible automatic programing system. This provides for presentation of either uniform or variable training problems, relieving the instructor of the mechanics of continuous trainer operations so that he can concentrate on monitoring the student response. The instructor's station contains both manual and automatic punch-tape equipment for controlling flight exercises.

The programer has a repeatable capacity of 50 training conditions such as radar warning, airborne attack or system malfunction. These can be activated at a maximum rate of one every 2 seconds for 10 hours, a total of 18,000 functions during a simulated mission far exceeding human reaction capability.

The instructor may freeze, interrupt, delay or repeat a programed mission sequence to critique and correct student responses and analyze problem areas.

Revising heading, position, altitude or speed references will alter the positions or ground return lines of simulated radars appearing on the student's instruments, as well as the attack angles, closing rates, and direction of attacking target aircraft or missiles. Course conditions inserted from the flight simulator similarly affect the problem.

• **Malfunction simulation**—The introduction of malfunctions and equipment failures likely to occur during actual flight can create realistic and frightening situations requiring analysis and hair-trigger response by the student. A myriad of typical malfunctions can be simulated; action required could range from use of emergency oxygen, to ignoring the warning lights or seeking causes of the indicated condition.

The student must constantly remain alert and utilize good judgment in the

emergency situations that are an ever-present reality of supersonic bomber operation.

• **Target simulation**—Of the many considerations involved in the design of the DSO Trainer target generators, probably most important, a Reflectone engineer said, was the requirement for a hybrid automatic-manual program control.

A completely programed or "canned" type of target generator bomber-control system was not acceptable, he recalled, because the simulated bomber had to perform evasive maneuvers involving speed and heading changes during a particular target run. The speed-change evasive maneuver is one of the major defenses of the B-58.

Further, the DSO instructor during independent mode of operation (or the student pilot in the interconnected mode of operation) must be capable of performing the exact evasive maneuver called for by the DSO student. The student is then able to monitor his flight control simulator display and see results of the specified maneuver.

A completely manual target generation system was not acceptable because of the lack of inherent realism and the additional load placed on the instructor. Also, a manual system could not provide the required repeatability for multiple-target attack patterns so that a particular attack pattern could be continuously presented for developing critical operating techniques. Finally, the same attack pattern must be presented to different students when the trainer is used to evaluate performance.

• **Variable targets**—Target programing is achieved by means of a Hickhock Cardomatic switch into which punched mylar cards are inserted. Target functions, programable for each of the three target generators, include 10 variable parameters.

Two target attack patterns are available: (1) The "pursuit" attack simulates infrared-homing missiles or a fighter aircraft following the pursuit attack pattern; (2) The second is the "lead-collision" attack which simulates a ballistic-type missile or a fighter aircraft flying a lead-collision course.

Target initial azimuth and target initial elevation (relative to specific aircraft axes) may be programed, as well as target initial range in 500-yard increments. Programed target speed in 50-knot increments is constant throughout the target run.

• **Targets and decoys**—Simulation of breakaway targets is achieved using programer card selections which cause targets to deviate from their pursuit or lead-collision path and fly-off, either right or left in ranges of from 0 to 4000 yards in 250-yard increments. When the target reaches the selected fly-off range, it turns right or left (as selected) at its maximum turn rate until it flies off the scope or until it reaches specific heading deviating from the bomber heading.

Decoy targets also may be simulated and made to deviate from the heading dictated by their pursuit or lead-collision course and fly a constant heading error.

The maximum performance rate at which a particular target will turn can be programed. Thus, if the pursuit or lead-collision path dictates a bomber turn rate or evasive maneuver exceeding the maximum turn rate of the target, the target will fly at its maximum turn rate, eventually flying off the scope, or until it is again on its pursuit or lead-collision course. A start-delay feature in each of the three generators may be used to delay time between initiation of each target from 2 to 30 seconds.

If the student correctly applies his ECM equipment to the attacking vehicle, the target will drift off the radar scope to simulate ECM success.

• **Controllable bomber parameters**—Non-programable bomber functions are provided in the trainer, so that bomber heading and speed may be changed at will during the target run to simulate evasive maneuvers. In the independent mode of operation, the DSO instructor has continuous control of bomber speed and is provided with an airspeed indicator and an ACCEL-DECEL switch for setting bomber speed and for performing speed change evasives. Rate of acceleration or deceleration may be set by means of a maintenance adjustment, and the instructor also has continuous 360° control of bomber heading.

In the interconnected mode of operation, bomber heading and bomber speed are obtained from the flight simulator.

• **Bomber roll and pitch**—The radar antenna in the aircraft fire control system is not stabilized in either roll or pitch; thus azimuth and elevation position of a target signal on the radar indicator is affected by aircraft movement.

In the interconnected mode of operation, pitch and roll are taken from the flight simulator. The independent mode provides for bomber pitch to be taken from the instructor's climb-div switch, and bomber roll from the instructor's right-left turn switch. Thus the instructor can accomplish the evasive maneuvers called for by the student during the training mission.

• **Computer design**—The analog computer employed in the simulation system is designed to produce pursuit or lead-collision attack courses, selected by means of the punched cards. In general, angular quantities are indicated by mechanical shaft positions and scaled quantities by d-c analog voltages.

The development of very accurate



*B-58 DSO SIMULATOR, built for Convair by Reflectone Electronics, Inc., includes trainee's compartment (at left), instructor's console (at right). The system permits complete training of the Defense System Operator, who is in charge of performing evasive maneuvers and electronics countermeasures for defense of the Strategic Air Command's Mach 2 bomber.*



*REALISTIC CONTROLLED training situations are presented to student DSO's, their responses are recorded, and performance evaluated, automatically. The student's compartment is a faithful reproduction of the DSO station in the B-58.*

elevation signals is not necessary; the only elevation indication in the radar system is the relative time sequence in which the several target signals flash on the "scope" indicator. This function is provided, however, with initial elevation set as a d-c voltage.

For a collision attack, elevation remains constant; for the pursuit attack, the elevation d-c is derived from a pursuit curve function potentiometer driven as a function of range.

• **Performance evaluation**—Scoring and evaluation techniques developed by Convair and Reflectone produced a design innovation which limits the amount of recorded information to "errors only." This procedure economically reduces analysis time, shows nature of errors in point of time during the mission, and permits faster instruction.

Real-time displays, duplicate controls and instruments, and switch position "tell-light" indicators make possible visual monitoring by the instructor. Student errors are recorded automatically and displayed until corrected. The reactions are recorded on paper tape, with voice commands or instructor criticism preserved on magnetic tape for later review.

The "Tel" system is the basis for all recording and visual observation of student performance. When the student and instructor switches are in positional coincidence, the instructor's tel lamps are extinguished and error signals are not fed to the recorder. If, however, the student's and instructor's switches are not in positional coincidence, the tel lamp corresponding to the student's switch position is illuminated and an error signal is applied to the appropriate recorder line.

The selective tel system operates with all student switches for which there is a proper or correct position at all points along the mission profile. This includes switches which are positioned according to preflight briefing as well as those which are positioned for mission events. The selective tel system monitors 22 individual student switches and 112 discrete switch positions.

In addition to the "selective" tel system, the instructor has a non-selective tel system which simply indicates the student's switch position. The non-selective tel system is applied to student switches for which there is not a proper or correct position at all points along the mission profile.

• **Mission programer**—An 8-channel punched-tape reader capable of handling tape for a 10-hour mission is used for programing. Individual items are programed to a time accuracy of ±2 seconds.

The eight channels provide the 50 separate activation switching functions by means of a relay matrix. Matrix outputs are so terminated as to allow each switching function to control more than one item. At the present time 96 functions are controlled by the programer, and the relay allows specific items to be changed readily.

The mission programer establishes comparison data for the selective tel system, initiates the six periodic recorder scans, inserts and clears malfunctions, initiates "fuse blow," bomber flight start, and airborne attack start.

• **Open-fuse simulation**—Since one of the vital functions of the DSO is to monitor major portions of the aircraft electrical system, the trainer contains a replica of the actual aircraft fuse banks containing over 400 fuses. Upon notification of a system malfunction, the DSO must locate and replace the inoperative fuse.

For training purposes, Reflectone developed a unique "mock" fuse with all the characteristics of an actual fuse, except that it can be "blown" at will by the instructor or programed tape and later reset for continuous use. The DSO operator must replace the fuse correctly from a supply of different "mock" fuses which are not exchangeable in rating. Insertion of an incorrect fuse will cause a malfunction and record an error.

• **Designed for the future**—In addition to the already comprehensive capability of the DSO simulator, its design includes provisions for retrofitting of the trainer coincident with changes in actual aircraft configuration, instrumentation or performance parameters. The installations, according to Reflectone, can be kept current with operational requirements or outfitted in advance of proposed changes to orient personnel. ⌗

## Standards for Measuring Dial Brightness Available

BRIGHTNESS of aerospace instrument dials and panels can now be measured by standards provided by the National Bureau of Standards.

The luminance standard consists of two components: a diaphragmed flashed-opal glass and an electric lamp. Flashed-opal glass is used because its transmittance is reasonably high (about 50%) and uniform over a considerable range of angles.

The luminance standards are used to calibrate any type of photometer. The photometer may then be used directly to measure the luminance of achromatic light-diffusing surfaces. With a color-matching filter of known transmittance as an additional component, the photometer will measure the luminance of chromatic surfaces.

Standards cost from $63 to $72, depending on size of the lamp, and may be obtained from the Bureau's Photometry and Colorimetry Section, in Washington, D.C. ⌗

# Big Switch to Glass-Plastic Cases

***Range of Minuteman, Polaris and Pershing will be lengthened by changeover; trend is highlight of SAMPE meeting***

**by Frank G. McGuire**

PASADENA, CALIF.—The ranges of *Minuteman, Polaris* and *Pershing* will be increased by completely equipping them with glass-reinforced plastic rocket motor cases.

Plans for the change-over were revealed at a symposium here of the Society of Aerospace Materials and Process Engineers. Although no one laid out timetables, there were unmistakable signs of a major trend in materials applications. Numerous programs in addition to *Minuteman, Polaris* and *Pershing* were alluded to, but not by name.

The symposium attracted more than 600 registrants representing every significant company in the glass, resins, plastics and filament-winding fields.

In addition to the switch from high-strength steels to composite materials in the major programs now underway, future applications for the new materials ranged from deep-diving submarines to ground support equipment, tanks for liquid-fueled rockets, radomes, and anything else capable of being designed around the properties of the glass-plastic families.

Glass was not the only reinforcing material discussed; attention was given to steel wires, beryllium, ceramic fibers, and other filaments.

• **Current program changes**—The most significant changeover now in the works for the glass-reinforced plastic case is the *Minuteman* three-stage vehicle. Wright Air Development Division has begun a program to demonstrate the suitability of the manufacturing methods, optimization of controls, equipment and processes, and other parameters enabling the switch to take place with complete confidence.

The structures for *Minuteman* must be completely designed from the winding patterns and materials aspects. The Air Force's Ballistic Systems Division is known to be somewhat dubious about the ability of glass-plastic motor cases to do the job, although it is reportedly quite hopeful. The program technical personnel at BSD feel that the third stage and first stage are different in more than just size.

A contract to come up with an acceptable first-stage *Minuteman* case has been let to Thiokol Chemical Corp. But the latter is believed to have teamed up with the B. F. Goodrich Co., since Thiokol hasn't sufficient in-house glass-plastic winding capability.

Use of glass on both stages of *Polaris A3* fleet ballistic missiles will significantly contribute to the goal of 2400 miles range. Currently being produced at Aerojet-General's Structural Materials Division in Azusa, Calif., the 13-ft.-long first stage case weighs only 800 lbs. without insulation, and is filament-wound with integral end closures.

The case has a stress level of 80,000 psi and a proof pressure level of 945 psi.

The second-stage motor case for the *A3* is only six feet long, weighs 200 lbs. without insulation, and is also filament-wound with integral end closures. Aerojet achieved its target weight figures on both cases.

Strength of the second-stage FBM motor is indicated by a stress level of 80,000 psi, and proof pressure level of 342 psi.

Nozzles for the *Polaris* are partly fabricated from cross-sectional segments



*FILAMENT-WOUND rocket nozzle is one of the many avenues being explored by B. F. Goodrich Company in the field of reinforced plastics.*

of fiberglass fabric with oriented fibers, compression-molded to size after being cut to shape and placed in a molding press. Refractory throat inserts are then assembled into the nozzle.

The Navy hopes to achieve mass stresses of over 200,000 psi within three years. Intensive research hinges on the fact that current fiberglass-reinforced plastics are using about half the available strength of the glass filaments. Since a glass case represents one-fifth the lead time and cost of a steel case, the Navy expects to push the glass-plastics.

Once missile rocket motors the size of *Minuteman* and *Polaris* are successful, little remains to prevent *Pershing* from traveling the same route. In the search for higher-strength cases for its "selective range" tactical missile, the Army has tried titanium cases which reached a yield level of 170,000 psi.

The difficulty with the B120VCA alloy was in the brittleness encountered at high strength levels. A similar problem had arisen in the *Minuteman* program, where a titanium alloy with 6% aluminum and 4% vanadium had reached strength levels of 138,000 psi, but only at the cost of brittleness.

As with the other programs now on the road to using composite cases, no timetable was revealed for the *Pershing* switch.

• **Glass-plastic submarines**—The possibility of a deep-diving submarine using a glass-plastic pressure hull was explored in a paper presented by J. E. Buhl, Jr., and J. G. Pulos of David Taylor Model Basin, and W. R. Graner, Bureau of Ships.

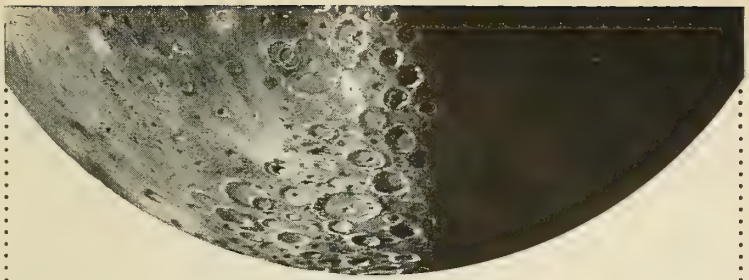
The authors reported on tests which had shown promise that composite glass-plastic materials might be successful. They expect development of materials superior to metals for the fabrication of submarine hulls.

In actual work conducted outside the Navy establishment, Aerojet-General is reported to have come up with a submersible hull shape using glass-reinforced plastics with a rubber-type sheath enveloping it. The hull is ring-stiffened.

The pressure hull, still in scale-model sizes, has withstood 10,000 psi external pressure, equivalent to a depth of 22,500 feet. Weight-to-buoyancy ratio is believed to be in the neighborhood of 0.5 for the material, indicating a positive buoyancy of the vessel, even when loaded with payload.

According to the paper presented to the symposium, the highest collapse pressure obtained was 7300 psi with a ring-stiffened hull. However, lack of specific details on the Aerojet hull prevent objective comparison of the results.

Extensive work for the Navy on the composite material hull was performed by Zenith Plastics Co. at its own expense. It was found that a higher glass

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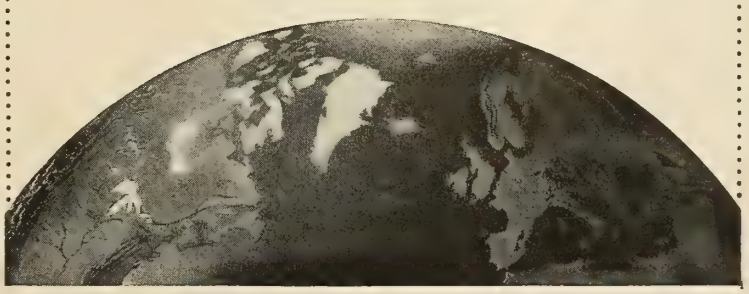
Mechanical or Aeronautical Engineer for fundamental analysis of ideal and real gas flow. An extensive background in thermodynamic cycle analysis is helpful.

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content provided for greater resistance to collapse in the test shapes. Content of glass ranged from 69% to 84%, with the latter showing best strength.

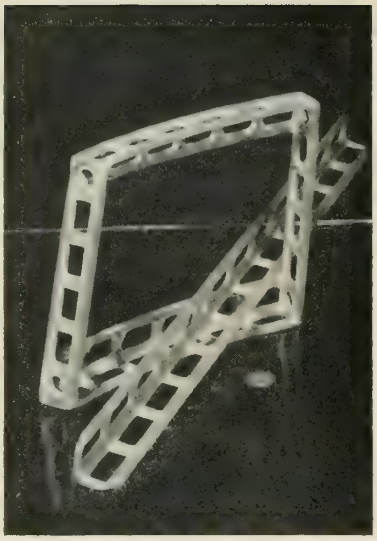
Both Navy and Aerojet researchers expressed concern over the effects of cycling on such a pressure hull. There is also some apprehension about long-term exposure to the deep submergence pressures. But work is under way to counteract both possible drawbacks.

A 50% reduction in strength was noted on test samples after 50,000 cycles, based on short-term compression strength. In long-term loading, unidirectionally wound glass-reinforced epoxy laminates, after immersion in water under flexural load equivalent to 56% of the short-time flexural strength, failed at 1000 hours.

• **State of the art**—George Peterson, Materials Central, Wright Air Development Division, said that most of the improvements in high strength-to-weight materials has been in component materials, rather than fabrication techniques.

Included in the component materials were vitreous fibers, silane coupling agents, and high-temperature, high-strength polyester, epoxy, phenolic and silicone laminating resins.

"AF considers that, even with the advances made to date and the continued effort in the area of new and improved component materials for filamentary structural composites, only isolated inroads have been made to obtain fundamental materials which can provide major advances in high strength-to-weight ratio composites."



*STRUCTURAL MEMBERS being perfected by Goodrich include this "chain frame."*

Peterson singled out for improvement reinforced materials, matrix materials, design of winding patterns and fiber orientation, and processing or fabrication techniques. He also called for a better understanding of the mechanisms of failure.

Ralph J. Brown, head of the preliminary design department of Aerojet's Structural Materials Division, cautioned that neither glass-reinforced plastics nor other composites are substitutes for metals.

"It's still necessary to design a structure around the benefits of these materials," he said, "and we still can't use composite filament-wound materials anywhere we like."

Brown pointed out that there is still no company in the business of making filament-winding machinery for missiles.

"And it's probably a good thing," he added, "because every time a company has to build its own, it uses what it learned from its predecessors, but improves on it. The result is an evolutionary improvement in fabrication machinery and techniques."

• **Prestressed pressure vessels**—A large step forward in increasing the strength of spherical pressure vessels was described by G. B. Wills and S. A. Dunn of Bjorksten Research Laboratories, and H. R. Worthington, Jr., of Scientific Engineering Institute. Their paper contends that the theoretical burst pressure of a thick-walled spherical pressure vessel can be greatly increased by pre-stressing the vessel.

Pre-stressing can be achieved, the authors said, but utilizing continuous filament-wound wall construction and controlling the tension with which the filament is applied. Through pre-stressing it is possible to obtain a uniform tangential stress throughout the vessel wall just prior to failure at burst pressure, rather than tangential stress varying as the inverse cube of the radius.

Effects of pre-stressing increase with wall thickness, and the paper points out that a pressure vessel made of material having an ultimate tensile strength of 100,000 psi, 9-in. thick wall, and 6-in. internal radius, will contain 530,000 psi in pre-stressed condition, but only 170,000 in un-pre-stressed condition.

• **Future for rocket cases**—Forecasting what is expectable from glass-reinforced plastic rocket motor cases in the near future, Elden Hawkinson of Rocketdyne described a solid-propellant motor case with the following properties:

—One nozzle port, probably with the nozzle wound in place.

—A length-to-diameter ratio between two and five.

—Case-wall operating stress level of 155,000 psi with a stress level at burst of 200,000 psi.

—Case modulus of 9 x $10^6$ psi.

—Strength-to-density ratio of 2.5 million in. at burst.

—Except for possible metal skirt attachments, filament-wound in place and a small polar boss at the forward end, no metal parts either in the case or in the nozzle reinforcement. ■

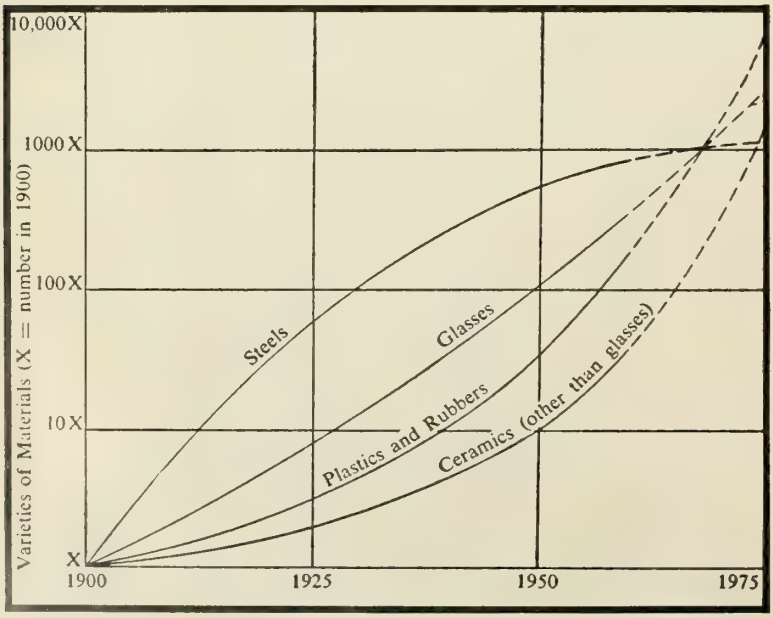



*CHART SHOWS THAT development of new plastics and rubbers, glass, and other ceramics will exceed steel in a few years. (Chart courtesy University of Michigan)*

# LOFTI Data Changes Thoughts on VLF

THE NAVY is taking a new look at very-low-frequency radio propagation as a result of information gathered with the *LOFTI* satellite.

Preliminary data indicates that some of the generally accepted concepts of VLF and its relation to the ionosphere may be due for revision. Principally, the experiment showed that while the ionosphere does reflect a large portion of low-frequency radiation back to earth, a substantial amount goes through and into space.

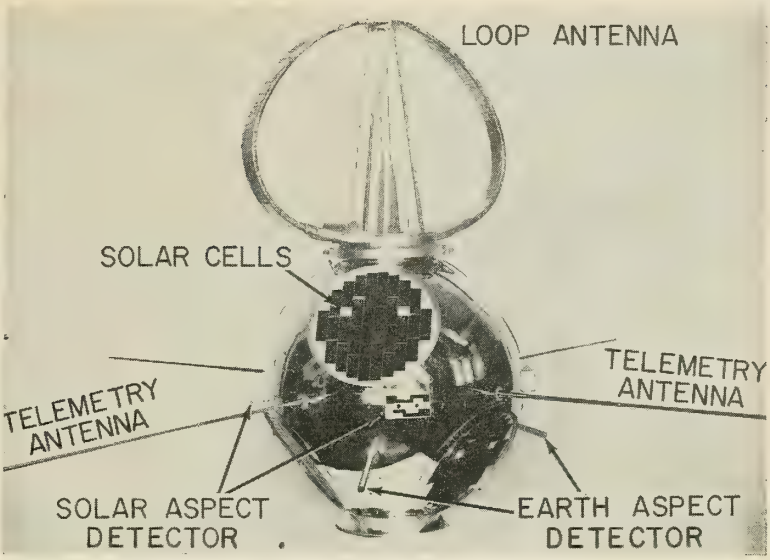
Considering this newly discovered phenomenon, Navy scientists foresee several important applications not previously considered. First, they say, it opens up the possibility of using VLF to transmit navigational data from earth stations to manned or unmanned space vehicles. Here, these frequencies have two important advantages:

—VLF is much less subject to interference by magnetic storms and other ionospheric disturbances.

—The longer receiving antenna and wider transmission beams of VLF require much less accuracy in aiming transmitting antennas to beam signals to spacecraft at long ranges.

The Navy says also that the experiment opens up the possibility of using satellites as a communication link with submerged submarines. Only the very-low frequencies penetrate the water's surface. Present high-powered VLF shore stations are vulnerable to attack and limited in range. Satellite stations would have considerable advantage in coverage and relative invulnerability.

There are no immediate programs to implement these new-found concepts into working space projects. The use of VLF poses some problems of its own which would have to be solved before practical systems could be developed. In the meantime, however, a whole new field of scientific investigation has opened up that could have a significant effect on advanced space communications systems. ⌘




# Discoverer XXII Orbit Failure Studied

DISCOVERER XXIII, slated for launch in about two weeks, may be delayed until malfunction of *Discoverer XXII* can be determined.

The exact cause of *Discoverer XXII's* failure to achieve orbit had not been determined by presstime, but an Air Force spokesman indicated that the cause was suspected to be a "mechanical malfunction—possibly in stabilization" of the *Agena* vehicle.

Launch, staging and separation sequences were all determined as "nominal" by the Pacific Missile Range tracking site at Point Mugu, Calif., and the entire shot appeared normal as it went out of the tracking station's range. But the vehicle failed to re-appear in an orbital path.

The recent *Discoverer* shot marked a first for the series—it was the initial use of Bell Telephone Laboratories' guidance system for the *Titan I* in the *Discoverer* series. The BTL system was selected to replace the prior tape-fed autopilot control method because its greater accuracy permits more precise control of apogee and perigee points.

Orbital weight of *Discoverer XXII* was 2100 lbs. for the *Agena* and 300 lbs. for the re-entry capsule. This is close to weights for all the recent shots with exception of *Discoverer XXI*, which had an orbital weight of 2450 lbs.

It had been planned to allow *Discoverer XXII* to remain in orbit between one and four days, depending on how successful an orbital track was achieved and on weather conditions in the off-Hawaii recovery area.

The capsule's "clinical zoo" contained everything from emulsion blocks for the Geophysical Research Division of Air Research and Development Command to six different algae types gathered from springs and geyser runoff areas in Yellowstone National Park. In addition, it carried two different types of virus, including one first isolated in the 1930's and maintained under controlled laboratory conditions since that time. Neither it nor the other, an enterotype virus, are contagious to humans.

Certain types of living tissues and cells were carried by *Discoverer XXII* similar to those carried by *Discoverers XVII* and *XVIII*—cells from human bone joints, including cultures exposed previously to radiation in the two earlier *Discoverer* shots; spores; and living tissue from the brain of an embryo chicken.

One non-biological experiment contained in the capsule was a set of silicone samples similar to the materials used in solar cells. This was intended as a test for Space Technology Laboratory in its study of radiation effects on solar cells and solar cell materials. ⌘

*Described to ARS . . .*

# Sapphire Whiskers for Safer Re-entry

PALM SPRINGS, CALIF. — Future spacecraft may use whisker-composite materials—expected to be three to four times stronger at white heat than any high-strength alloy on a pound-for-pound basis.

Dr. W. H. Sutton, of General Electric's Missile and Space Vehicle Department, outlined the development at the American Rocket Society's Lifting Re-entry Vehicle Conference.

Preliminary work is aimed at combining aluminum with whiskers of pure sapphire in such a way that one square inch of composite could withstand a tension of several hundred thousand pounds.

Sponsored by the Bureau of Naval Weapons, the program is designed to achieve a strength-to-weight ratio of 600,000 in. at 2000°F.

The whiskers are combined with aluminum as a bonding material. A completely successful composite will have nearly all of the stresses borne by the whiskers. Combination procedures include impregnating the molten aluminum with a pack of whiskers under vacuum or mixing whiskers with powdered aluminum and then heating.

A major difficulty is a tendency for pores to appear in the composite. This occurs when the bond between the constituents is incomplete.

The sapphire whiskers are grown by oxidizing aluminum in a hydrogen-water vapor atmosphere. The alumina is deposited as single-crystal growths.

One critical area is in the establishment and precise control of all the conditions present during the growth of the whiskers and the fabrication of the final composite material.

Plans are under way to develop composites using steel or other high-strength refractory metals.

• **Re-entry Techniques**—The destructive heat stress caused by re-entry conditions could be held within acceptable limits by integrating protective materials with the vehicle body structure.

This would eliminate the need for independently-mounted "shingles" despite the problems of vehicle buckling and distortion, said S. Levy, of G.E. General Engineering Laboratory.

The integrated approach accepts the stresses for the sake of light weight and good maneuverability. The shingle method protects against these stresses with free-mounted insulation material but accepts some sacrifice in weight and maneuverability.

Pyrolitic graphite applications were discussed by Dr. S. M. Scala, G.E., MSVD, in nose and leading edge areas. The material would offer heat protection under long-time flight conditions that produce gas temperatures of about 13,500°F and surface temperatures of about 4500° F. ‡



**A Cooler Approach to Re-entry**

*MANNED SPACECRAFT designed by Douglas Aircraft would cut down re-entry heat by "mushing" and rolling through the atmosphere, instead of depending upon heat-absorbing materials. Wind-tunnel model tests show that the design has a gliding ability comparable to that of a DC-8 jet transport.*

## Gilruth to Choose Date And Astronaut for MR-3

MERCURY DIRECTOR Robert R. Gilruth now has full authority to choose an astronaut and schedule the first manned ballistic flight when he decides the time is ripe.

NASA has approved Gilruth's checkoff list of remaining items. When he is satisfied, Gilruth will order the beginning of the 12-day countdown in preparation for *Mercury Redstone 3*.

Four major items remain on Gilruth's list—another *Little Joe* flight, centrifuge tests for the three finalist pilots, completion of landing bag drop tests and completion of the pilots' familiarization with system and capsule.

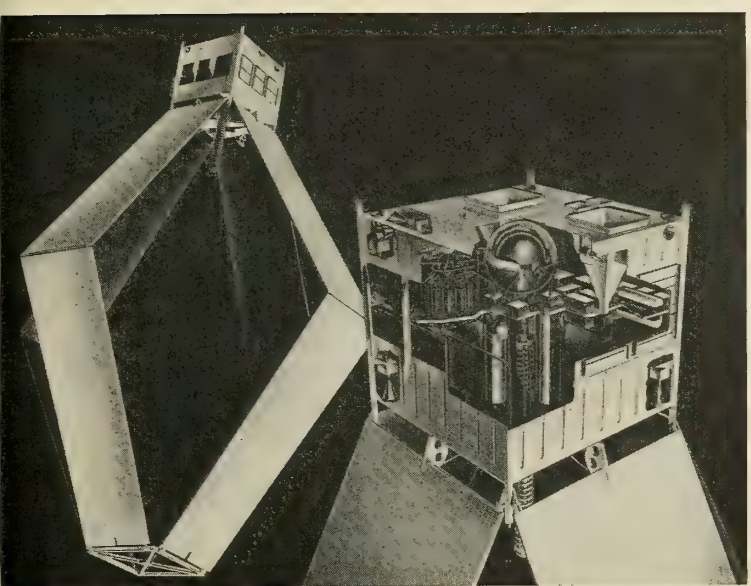
The *Little Joe* flight date has not been set, but it may take place the week of April 17.

The air drop tests already appear to have proved out a design change on the capsule landing bag—the addition of 24 cables of ¼ in. diameter to strengthen its connection with the capsule heat shield. However, more drops will be made to be certain.

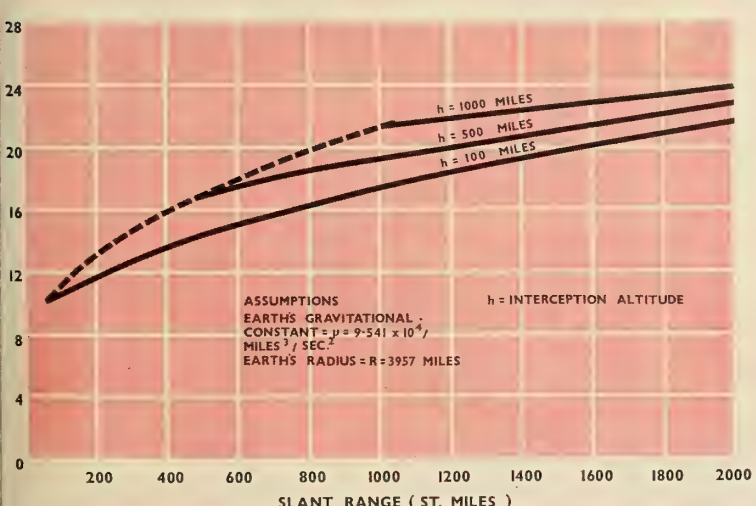
The astronauts themselves must certify their system familiarization. ‡

# Franco-British Report Sees Satellites Up by '64

by Bernard Poirier



*OMMUNICATIONS SATELLITE design offered by Hawker Siddeley Group and EREB in Western European industry's first aerospace study project.*




*ELOCITY REQUIREMENTS (5K ft/sec. loss) for nuclear interception of satellites.*

ONE OF the most ambitious plans for joint space cooperation by Britain and France would take $800 million over the next four years.

Scientists of Hawker Siddeley and Société pour l'Etude et la Réalisation d'Engins Balistiques who collaborated in a recent report contend that, given a green light by July 1961, the combine could orbit satellites by December, 1964.

Assuming minimum blind avenues of implementation, they say only $300 million is needed for "research, equipment, data acquisition and handling."

Development of carrier vehicles (unspecified) is estimated at $300 million and specific space applications, $200 million.

The report states Compagnie de Télégraphie Sans Fils of France is presenting with SEREB a satellite navigation system based on the use of atomic clocks which could compete with Doppler systems. (CTSF has been credited recently in the development of a new Maser electronic screening system.)

• **Satellite details**—One Communications Satellite design would provide satisfactory operations in most orbits. The total weight of the satellite would be about 550 lbs. To be projected in one particular orbit would require a launch/payload ratio of about 350 assuming 250 lbs. specific impulse.

This stabilized satellite with high radio power could operate between 4000 and 10,000 miles. For a system serving mainly the Northern Hemisphere, a 63° inclined orbit has a distinct advantage.

The report says: "In particular, the apogee would remain at any particular latitude, thereby cutting down on the number of satellites necessary to provide a continuous (communications) service." Perturbation could rotate the system around the polar axis by about 15° per month. Assessment of this would determine the total satellites needed.

Their design requires stabilization of the satellite so it points earthwards and would use infrared radiation sensitive photo-cells to align with the horizon.

Initially the stabilization system would contend with residual angular velocities after separation and during the erection of the satellite from its horizontal position (see photo).

A known but varying angular velocity must be applied to maintain an earthward direction of the satellite as opposed to a tangential inclination, the report says. The torques required for correction would be beyond the stabilization characteristics of the earth's gravitational field.

Constant corrections particularly would be required to offset solar radiation and possible drag effects in the perigee region.

• **Temperature control**—The Europeans determined the correction device should rely on a propane fed reaction (jet) system. They dismissed consideration of a mixed reaction, jet/flywheel system which can be complicated by a high rate of leakage and extended thrust operations.

Satisfactory temperature control to protect internal electronic functions would be "accomplished by the use of specific surface finishes with absorptivity/emissivity ratios permitting regulated influx and efflux of heat."

The satellite would vary in distance from 12,500 miles to 300 miles, with a variable aerial beamwidth. The aerial's maximum gain would be 18 db and the minimum, 3 db. By establishing a mean value of 10 db at 4000 miles for consideration of one watt transmission under adverse fading conditions (of 10 db), the power received is established at about $4.5 \times 10^{-14}$ watts.

Significantly, the reports says, "with a Maser type of receiver input the carrier to noise ratio for a 1 Mc/s bandwidth is about 16 db. This is a great improvement on a conventional valve and even on a parametric amplifier type.

Their final analysis suggests frequency modulation for which the maximum usable bandwidth corresponds to a carrier to noise ratio of 12 db and for the Maser type of receiver, about 2.6 Mc/s (French=2, 6 MHz).

The carrier frequencies, then, would be 6000 Mc/s for ground to satellite and 2000 Mc/s satellite to ground with four 2.6 Mc/s wide bands using a non-demodulating I. F. repeater suitable for FM signals.

The radiated power from the satellite would be 4 watts total. There would be 100 two-way telephone channels S/N ratio 40 db and 32 two-way channels, 50 db.

The choice of propane for attitude control (controle d'assiette) was determined by its ready volatility and stability compared with H.T.P. Kept at a constant pressure (350 to 400 p.s.i.) by pressurized nitrogen and separated by a plastic diaphragm, the propane would be controlled by a displacement type injector.

The French and British technicians came up with vaporization of the propane by heat from four travelling wave tubes via lithium compound heat sinks. Heat output would be about 60 watts.

Another communication system also was proposed which offers several alternatives depending on payload and orbit as determined by the apogee. One omnidirectional 60 channel satellite would apogee at 6000 miles, the second with 120 channels and a 9300 mile apogee and the last, another 60 channel omnidirectional design but with a low 2500 mile apogee. ⌗

# Australia's Malkara Death To Bunkers

**by Alan S. Hulme**
*Australian Minister for Supply*

*(Dramatic evidence of the Malkara's adaptability to jungle warfare, as described in the following article written for M/R, is shown in the photos at right of the weapon blowing up a bunker. The Malkara is solid-fueled, is 6.5 ft. long, has a 2.5 ft. wingspan and weighs at launch 206 lbs. It has a range of 2 mi.—Ed.)*

AUSTRALIA'S *Malkara* wire-guided missile was designed for several roles of which one was tank destruction and another the destruction of bunkers of the type frequently encountered during the last World War.

Bunker defenses, often interconnected in an elaborate manner, were used extensively in the Pacific Theatres. Heavy casualties were experienced against them and, in at least one case, casualties amounted to several thousand men.

A bunker is designed to be strong overhead and, to the maximum extent possible, to resist blasts alongside. One vulnerable feature of any bunker is the frontal firing slot used by the defenders.

Owing to ballistic trajectories, a gun was generally ineffective except at close range. A guided weapon, on the other hand, can achieve sufficient horizontal flight to enter.

The Australian Army and the Department of Supply have conducted many tests against bunkers typical of those encountered in South East Asia.

These were of two sorts—the "log earth" and the "log stone" bunkers. In these tests, a trench was covered with three layers of 10-in. hardwood logs spiked together. The first type was covered by three to four feet of compacted earth; the second type, with three to four feet of broken bricks and stones. The slit measured 5 x 1 ft. at ground level.

Sixty-pound experimental warheads containing 35 lbs. HE were used with instantaneous fuzes. (A *Malkara* easily penetrates ½-in. steel plates. Its high kinetic energy coupled with a delaying fuze would allow even deeper penetration and greater impact.)

Three rounds were fired from about one mile with perfect accuracy. In each case, one *Malkara* fully neutralized the bunker.

Blast recording instruments in the bunkers indicated that all the occupan would have been killed. The shots wer purposely guided to hit the slit edg along the vertical center line of th bunkers.

These trials clearly demonstrate field accuracy and high lethality again defenses of this type. For instance, a enemy bridge could be destroyed b exploding a substantial charge again one of its supports from a distance o several miles.

The *Malkara* would have almost th same precision as a sabotage par placing the explosive.



# C-V, L-T Merger Will Form a Giant

***Wedding of two companies with wide-ranging capabilities is seen producing one of top ten DOD contractors; officers chosen***

COMBINATION of Chance Vought Aircraft, Inc. and Ling-Temco Electronics will make the new company one of the top 10 military contractors, and Dallas a major missile/space center.

Stockholders of both companies will meet by early summer to approve the merger and choose a new name for the company. Chance Vought's stockholders meet May 28.

Although the courtship was one-sided, the union may prove a happy one. Combined sales for the two companies for 1960 were $362 million, with combined profits of almost $7 million. Combined backlog—mostly government orders—totals more than $300 million.

The merger will give the new company a potential systems capability in the class of the Lockheeds, Boeings and Martins, many observers say.

• **Potential**—Vought has aeronautics, astronautics, electronics, range systems and research divisions, and subsidiaries in data processing, underwater engineering, industrial automation and mobile homes. It recently was awarded subcontracts for work on the B-70, *Dyna-Soar,* a NASA contract for the first stage of *Saturn* and prime contract for the NASA *Scout.* The company is building a multimillion-dollar space simulator center in Dallas.

Ling-Temco—with the added missile capability of Temco Aircraft, which it absorbed last June—did almost 80% of its business last year in electronics, communications, missiles and aerospace systems. It built the *Polaris* radio station, increased its *Nike-Zeus* acquisition radar transmitter program, and built radar transmitters for BMEWS, Iconorama systems for BMEWS, SAC and NORAD. L-T's divisions worked in sonar, environmental testing sound systems for missiles, electromagnetic reconnaissance and electronic countermeasures. Ling also held contracts in systems development and production on the *Terrier, Polaris, Hawk, Sergeant, Davy Crockett* and *Minuteman* missiles.

The merger culminated a drive begun several months ago by Ling-Temco to buy up a controlling share of Chance Vought's stock. Despite vociferous resistance by former C-V president Frederick O. Detweiler—backed up by court suits citing the anti-trust laws—Ling interests managed to corner 38% of Vought's stock.

Detweiler, recently named to the post of chairman of the board of C-V, will move out entirely after merger negotiations are completed. Gifford K. Johnson, former executive vice president, is Chance Vought's new president and chief executive officer. He will be president of the new corporation.

Other officers in the new corporation will be: chairman and chief executive officer, Robert McCulloch, who presently holds that position at Ling-Temco. Chairman of the executive committee will be James J. Ling, president of Ling-Temco. Executive vice president will be Clyde Skeen, who holds the same position at Ling-Temco.

All lawsuits filed by both companies against each other will be dropped.

• **Stock exchange**—New stock probably will be issued, with the same value as Ling-Temco stock.

Chance Vought shareholders will receive a $43.50 debenture per share in the combined companies' debentures and warrants. This debenture will be worth 1¼ share in the new company (for the first five years). Each debenture bears a 5½ % interest coupon, plus a five-year warrant to buy 1/5 share of new stock at $30 per share, and a five year warrant to purchase 1/5 share of new stock at $40 per share. This was done to compensate for the higher value of Chance Vought stock.

Although Ling-Temco will be the surviving corporation according to the Boards of Directors agreement, Chance Vought is the bigger company. Its 1960 income was $3.9 million on sales of $213.9 million—of which 65% was in defense contracts. The company's totals slipped from income of $4.9 million on sales of $254.7 million in 1959.

Ling-Temco's 1960 sales approximated last year's at $148.7 million. The company managed to make up for a $16-million loss in planned sales when the Navy cancelled part of the *Corvus* missile program. Earnings rose slightly to $3.051 million, from $3.029 million.

The two companies have a combined payroll of about 20,000, 15,000 of whom are employed at Dallas. ⌘

## expansions

**THE MARTIN CO.** has set up a department to integrate all its nuclear chemistry activities at Baltimore and Quehanna, Pa. Dr. Charles E. Crompton will head the group. The department will include a new automated laboratory at Baltimore for processing "man-made" chemical elements, and a series of heavily-shielded "hot cells' leased by the company at Quehanna for remote handling operations.

**ELECTRONIC SPECIALTY CO.** of Los Angeles has acquired D. S. Kennedy & Co., which has facilities in Massachusetts, Texas, Iowa and Alabama. Stock will be traded at four shares Electronic Specialty for five D. S. Kennedy shares.

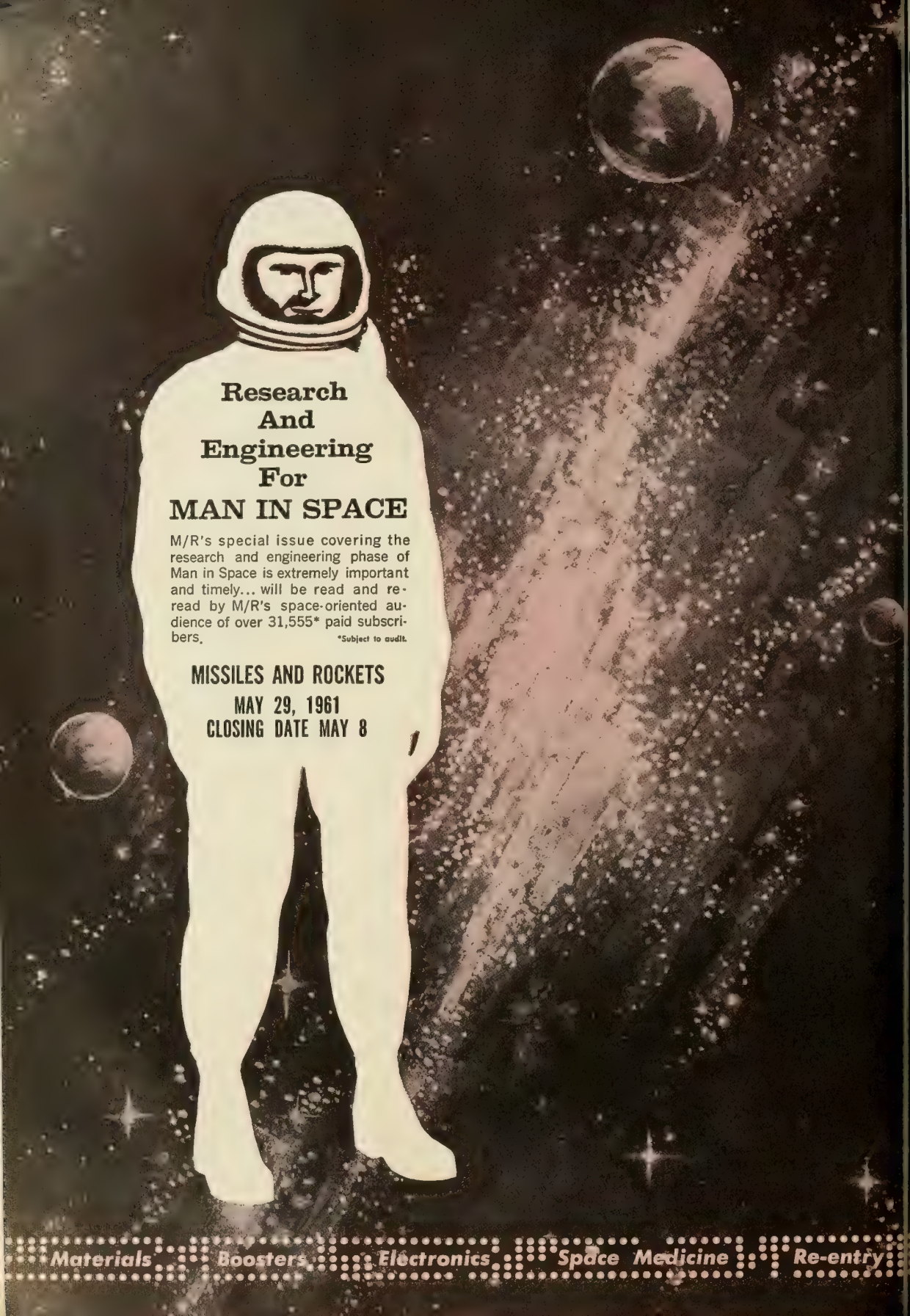
## financial

**Avco Corporation**—Sales and earnings alike exceeded 1959 totals. Net sales were $322.7 million, compared to $306 million. Earnings reached $10 million, surpassing $9.6 million in 1959.

**Lockheed Aircraft Corp.**—The company moved into the profit columns during the second half of 1960 with earnings of $12.5 million for six months, reducing its net loss to $42.9 million. Sales rose slightly to $1.33 billion for the year ended Dec. 5, compared with $1.30 billion for 1959. Backlog stood at $1.22 billion, compared with $1.16 billion a year earlier.

**Aerojet General Corp.**—Consolidated sales for the corporation for the three months ended February 28 were $108.97 million, compared with $93.99 million the same period a year ago. The sales figures were up 16%. Earnings rose 17% from $2.1 million to $2.5 million for first-quarter 1961.

**General Dynamics Corp.**—Net sales for 1960 were $1.99 billion, compared with $1.8 billion the previous year. Net loss for the year was $27.1 million, after $80.3 million writeoff on the 880/990 program. This compares to a 1959 profit of $31 million, during which year the company wrote off $25.8 million on its jet program.


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# Federal Property Rules Need Changing

**by John D. Truesdale**

*Supervisor, Operations Engineering Control*
*Missiles and Space Division*
*Lockheed Aircraft Corp.*

IT'S BECOMING increasingly difficult for missile/space manufacturers to live with the regulations controlling the handling of government property—mainly because most of them were set up for aircraft-production-type contracts.

In general, the regulations, given in the familiar Armed Services Procurement Regulations (ASPR), have not been updated for missile/space research-and-development-type contracts.

• **Problems of transition**—Under production conditions, all special tooling is ordered by manufacturing divisions for use in the shop and on assembly lines. Under missile/space R&D contracts, however, a major portion of special tooling is ordered by engineering divisions, whose officials usually are not familiar with the workings of Federal special tooling regulations. Consequently, special tooling accountability procedures are not implemented.

Many engineering departments have yet to learn the meaning of "special tooling": an item of special tooling, as opposed to capital equipment (either contractor- or government-owned), is one which is peculiar to the needs of the government—that is, the equipment item is not a standard catalog item being procured for general-purpose applications.

It is generally believed that the government's intent is as follows:

1) The contractor shall not buy fixed-asset type equipment under the guise of special tooling.

2) The contractor shall maintain accountability records for special tooling.

3) The contractor shall have freedom to rework, modify or alter this equipment as may be necessary to perform the applicable contract. Should the contractor change the configuration of special tooling equipment so that it takes on the characteristics of a general-use capital equipment, the special tool must be transferred, for accountability purposes only, to the contractors' plant account as a government-owned capital item.

Some companies are erroneously establishing specialized support-equipment (special tooling), acquired with R&D contract funds, as plant equipment for which official plant account records must be maintained. Immediately upon delivery of this equipment, modifications become necessary and are freely made in order to get the job done. Technically, this is a violation of the regulations; plant equipment should not be altered, and if it is altered contracting officer prior approval is required.

The new factor causing this problem is the multimillion-dollar cost-plus-fixed-fee R&D contract. Prior to the missile/space era, R&D activities were relatively confined; for example, an aircraft could be developed and tested at the production facility. Prototype tooling was relatively inexpensive and could be adapted into the production line when the airplane design became fixed. The goal was always the same: mass production. There was, and is, very little said in ASPR about prototype, or experimental tooling. ASPR regulations are fundamentally written for production-type operations.

There was one area, even under production contracts, where the contractors were constantly running into disallowance problems. Special electronic checkout equipment complexes were allowable contract cost items, as long as they were not of a general-purpose, capital nature. When a number of standard, capital-type electronics components were assembled into the complex, and the cost of the entire complex was charged to the contract as special tooling, a wide area of interpretation became apparent.

Disputes on these matters usually did not arise until the time of contract-termination audit. Under today's missile/space contracts, 40-60% of the costs may involve this same type of electronic checkout, test and support equipment.

The lack of clear regulations and uniform interpretations will lead the contractors and the government down the primrose path to property-accountability chaos; and the problem may not be recognized until it is too late to trace any audit trails.

## *Chief Problems with Government Property Regulations*

**1)** Regulations are not compatible with the needs of missile/space R&D.

**2)** Contractors cannot comply with the regulations as they are being interpreted.

**3)** Government organizations responsible for negotiating and administering R&D contracts have unintentionally misguided contractors with respect to property procedures.

**4)** Contract administration offices of the contractors consider the regulations' problem too procedural to warrant intensive consideration.

**5)** Industrial engineers and procedures writers, unable to obtain informed guidance, have set out on their own to solve the regulations' problem; however, the constant internal reorganization characteristic of missile and space contractors has seldom allowed the job to be finished.

## 'Design-as-you-go' attitude . . .

Missile/space programs are based on R&D contracts necessarily involving generalized work statements. Attempts to make definitive support-hardware requirements have generally proven impractical. As soon as a list is negotiated, it is obsolete.

As a result, a philosophy of "define-as-you-go" prevails with respect to support equipment. The project engineering organizations normally establish the need for support equipment. Based upon a description of such items, an administrator must decide on several possibilities:

1) The item may be of a specialized nature, and therefore qualified as contract special tooling.

2) It may be expendable—that is, it may be destroyed during test operations, and therefore qualified as contract material.

3) It may be a deliverable end item defined in the R&D contract, or in a supplementary supply contract specifically negotiated for support-equipment hardware delivery.

4) It may be of a capital nature—for example, a standard computer to be used at a government test base or tracking station. We would have to assume that there was a facilities' contract covering the test base or tracking station. However, such an item may be charged to the R&D contract with special approval of the contracting officer.

5) If the item does not qualify under any of these categories, it must be assumed to be either a) fixed asset, b) facilities' contract item, c) item of expense (overhead), d) item to be furnished by the government under a bailment agreement, e) item of GFE (government-furnished equipment) handed to the contractor for incorporation into a deliverable end item, or finally, f) item of GFE to be handled by the contractor as an item of special tooling or expendable material.

One thing is clear: the project engineer must have an administrator who is well-informed in matters of property administration, if he is to get the job done and still comply with the contracts.

Normally, government contractors have separate procedures and forms for ordering and establishing accountability for 1) contract deliverable end-item material and test material, 2) special tooling, 3) fixed asset and facilities contract items, 4) expense (overhead) items, and 5) bailment items. If these procedures do not implement the applicable ASPR identification and accountability regulations, or the administrator guesses wrong at the proper classification of property, the contractor will most certainly be headed for trouble.

• **Special tooling consoles**—One major contractor revealed an agreement with the contracting officer whereby removable, standard, capital-type components of special tooling consoles would be procured as fixed assets. Over a period of time the company probably will have difficulty maintaining these fixed assets on the books. An engineer working to tight schedules is not apt to report necessary rework of modification.

Also, fixed assets normally require strict location control for financial reasons. These consoles and their fixed asset components will, of necessity, have to move freely between work areas. This is an unusual misinterpretation of ASPR, because it is to the contractor's disadvantage. Generally, it has been agreed that any component of an item of special tooling, whether the tool is a console of a shop fixture, should be charged to the contract as special tooling, and identified and accounted for as a component of the tool.

• **Tagging special components**—Some contracting officers are requiring contractors to place capital-type plant equipment tags on components of special tooling equipment that are removable and may be used separately as general-purpose, capital-type equipment—e.g., an oscilloscope. Such a possibility naturally concerns the contracting officer because a component of special tooling need be accounted for on the tool record only, and may lose its identity in the course of modification or alteration.

At the termination of a contract, remaining special tooling inventory is normally compared to the total expenditures for special tooling. When there is an unreasonable discrepancy, the contractor may be reprimanded. On the other hand, tagged plant property must be accounted for according to the same procedure governing capital-type facilities (plant equipment). How does this affect the contractor? Under such circumstances the contractor *cannot* follow the contracting officer's instructions, and still comply with ASPR.

The reason is this: components of special tooling, regardless of their nature, are necessarily subject to continuous modification, rework and damage. As a result, those special tooling items, for which accountability records are established in the plant account, lose their configuration identity, and the government may demand that the contractor return the items to their original configuration.

To accomplish the complex tests required under missile/space contract work statements, many standard off-the-shelf equipment items must be submitted or exposed to destruct, or near-destruct conditions. Contracting officers have required contractors to tag these items and establish plant account records for them. It is obvious that such equipment will seldom be maintained in a condition or configuration required by the accountability regulations governing government-owned plant equipment.

• **Ground support equipment**—Under R&D missile/space contracts, GSE normally is not designated as deliverable under the terms of the contract. Therefore, one would logically conclude that this GSE is special tooling. This may cause difficulty, because many GSE items are standard, capital-type equipment items. Most contracting officers have required tagging of this equipment as plant account property.

Since engineers at test bases and tracking stations must continuously modify GSE, it is difficult for the contractor to comply with the regulations governing equipment which is accountable as capital-type, plant-account property. It is almost certain that the engineers will not obtain contracting officer's approval prior to altering this equipment.

• **Shop accessory dilemma**—Contracting officers, under certain Navy contracts, have tried to implement "Shop Accessory" controls on specialized equipment acquired with R&D contract funds. "Shop Accessory" is the Navy term for special tooling. The regulations governing Shop Accessories (OSTD 100) were intended for production conditions. Application of these regulations to R&D contracts has proved impractical.

Here are the reasons: R&D work is unreasonably restricted by freezing the design of an item of special tooling equipment and implementing design drawing control; also, it is financially impractical to require that components of special tooling test equipment be permanently married to the parent equipment item. Without the freedom to interchange components between equipment items, the cost of specialized equipment under R&D contracts would reach fantastic proportions.

This nation's successes in the missile/space field can be attributed primarily to cooperation and mutual trust between the government and its contractors in private industry. Continuous bickering over problems involving government property regulations could have a deteriorating effect upon this relationship. There is an urgent need to completely re-evaluate government property regulations and their application to current conditions.



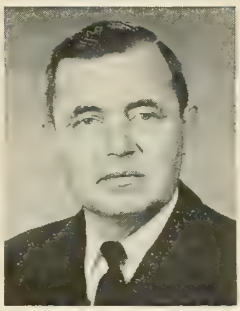
FFNER



LEVITT



KONKOL



TEBO



LYONS

**David Z. Robinson:** Assistant director f research for Baird-Atomic, Inc., ap-ointed technical assistant to **Dr. Jerome ). Wiesner,** President Kennedy's special ssistant for science and technology.

**Benjamin F. Ruffner:** Former director f the product research office, promoted to hief of technical staff for Boeing Air-lane Company's Aerospace Division, eattle.

**Dr. Sherrerd B. Welles:** Appointed cor-orate director of engineering and re-earch, Sanders Association, Inc., Nashua, N.H., Previously he was manager of the Missile Systems Laboratory and served as echnical assistant to the vice president in harge of research and engineering for ylvania Electronic Systems.

**L. R. Barr:** General manager of the Lear-Romec Division, elected vice presi-ent and general manager of Lear, Inc., Elyria, Ohio.

**George G. Brown, Jr.:** Named manager f Vehicle Systems Programing at North American Aviation's Space and Informa-ion Systems Division, Downey, Calif. Previously he was the division's repre-entative to the AF Ballistic Missile Division.

**Dr. I. M. Levitt:** Internationally recog-ized space scientist, astronomer, director f Philadelphia's Fels Planetarium of the Franklin Institute and M/R contributor, appointed a member of the board of direc-ors of Decker Corp., Bala-Cynwyd, Pa.

**John R. Edmonds:** Appointed director f production for Allied Chemical's Gen-ral Chemical Division, N.Y. Edmonds as been with the division 21 years in vari-us technical and supervisory positions.

**Charles W. Henderson:** Named assist-nt to the president of Ets-Hokin & Gal-an, Inc., San Francisco. Henderson also will be in charge of the company's Wash-ngton Office.

**Dr. R. D. O'Neal** and **R. H. Isaacs:** Vice presidents in charge of engineering and government relations, respectively, of the Bendix Corp., Detroit, elected to the company's administration committee.

**William E. Bradley:** Appointed manager of the Aero-Space Computer Section of Philco, Willow Grove, Pa. **Howard W. Edminister** appointed to the semiconductor sales engineering staff of the Lansdale Division.

**Arthur A. Katz:** Veteran of over 10 years' experience in the electronic computer field, named to the newly-created position of manager, applied programing, RCA Electronic Data Processing Division, N.Y.

**Ezra Kotcher:** Former technical director, Directorate of Advanced Systems Technology at ARDC, Wright-Patterson AFB, Ohio, appointed to form and manage a San Francisco Bay area office of Aerospace Corporation.

**Kenneth M. Tebo:** Appointed director of management control and analysis for the Milwaukee plants of AC Spark Plug Division of General Motors. Tebo helped institute the PERT (Program Evaluation Review Technique) for the Navy on the *Polaris* program, and will set up a new activity of this type for AC-Milwaukee.

**Raymond E. Stankard:** Manager of tactical warfare systems sales, named administrator of contracts for the Aero-Science Sales group of Goodyear Aircraft Corp., Akron, Ohio. **William L. Leek,** manager of metal sales, given responsibility for rocket motor case and lighter-than-aircraft sales.

**Dr. Richard E. Hillger:** Appointed vice president for research of AirTechnology Corp., Cambridge, Mass. With ATC since 1952, he participated in the AEC nuclear tests at the Pacific Proving Grounds and the Nevada Test Site, and also supervised the optical and photogrammetric instrumentation used in rocket-sled tests of inertial guidance systems at Holloman AFB.

**John D. Gum:** Former assistant director of systems engineering at Consolidated Systems Corp., Monrovia, Calif., promoted to director of engineering.

**Lambert F. Lyons:** Elected vice president-director of engineering of American Avionics, Inc., Los Angeles. Previously he was chief of the missile guidance department at Bendix-Pacific.

**J. Nelson Lord, Jr.:** Joins Washington staff of General Dynamics/Electronics. Former assistant to the president of the Allen B. DuMont Laboratories.

**George Konkol:** Former general manufacturing manager of the Parts Division at Warren, Pa., appointed general manager of Microwave Device Operations, Sylvania Electric Products, Inc., Mountain View, Calif.

**Mundy I. Peale:** President of Republic Aviation Corp., Farmingdale, L.I., elected to the Board of Directors of Bausch & Lomb, Inc., Rochester, N.Y. **Harold Schroeder** appointed head of the newly-created Optical Coating Process Department.

**Lester K. Suydam, Jr.:** Appointed semiconductor sales engineer for Philco's Lansdale Division with offices in Syracuse, N.Y. **A. F. Parker** named manager of export sales for Philco's electronic data processing systems.

**William C. Hennings:** Former manager of the Receiver Development Branch, appointed manager of the Space Systems Branch of Melabs, Palo Alto, Calif. **Hugh L. Gottfried** named manager of the Reconnaissance Systems Branch. Prior to joining Melabs, Gottfried was with the USN Radiological Defense Laboratory and the Electronic Defense Laboratory.

**James DeLuna:** Named director of Central Region Marketing for Northrop Corporation's Nortronics Division with headquarters in Dayton, Ohio.

**Thomas B. Mechling:** Elected executive vice president of Aero Geo Astro Corp., Alexandria, Va.

**J. M. Bridgman:** Appointed vice president and general manager of Litton Systems (Canada) Ltd., Beverly Hills, Calif. **Victor V. R. Symonds** named contracts manager.

# contracts

## NASA

$195,000—**Armament & Control Section of GE's Light Military Electronics Department**, for gyroscope utilizing electrostatic rotor suspension techniques. Subcontract from **California Institute of Technology Jet Propulsion Laboratory.**

$119,613—**General Electric Ordnance Department**, for development of a cryogenic accelerometer.

$80,000—**Tracerlab**, Waltham, Mass., for R&D on detection of atomic gases in outer space.

$44,219—**Electro-Optical Systems, Inc., Fluid Physics Division**, Pasadena, Calif., for analysis of tests needed to evaluate performance of electrostatic propulsion systems in space; and $74,941 for ionizer development and surface physics studies.

## MISCELLANEOUS

$550,000—**The Panellit Division of Information Systems, Inc.**, Los Angeles, to furnish instrumentation to the **General Electric Company** for use at the Hanford Atomic Products Operation, Richland, Wash.

$125,000—**United Control Corp.**, Seattle, from **North American Aviation, Inc.**, for power distribution panels and environmental control systems.

$125,000—**Summers Gyroscope Co.**, Santa Monica, Calif., from **The Martin Company's Orlando, Fla., Division**, for spring-wound gyros for use in trainer missiles.

## NAVY

$1,211,000—**Republic Aviation Corp.** from **Grumman Aircraft Engineering Corp.**, Army & AF, for guidance systems for *Bullpup* missiles, advanced research in space electromagnetics and qualification tests for subminiature electronic modules and work in the field of surveillance drones.

$453,649—**Lenkurt Electric Co.**, San Carlos, Calif., for communication carrier system service between Cape Canaveral and Patrick AFB.

$334,384—**Tracerlab**, Waltham, Mass., for 58 air particle monitors.

$282,151—**Aircraft Armaments, Inc.**, Cockeysville, Md., for design, development, and fabrication of missile trainer, firing set assemblies.

$274,257—**RCA Defense Electronics Products**, Moorestown, N.J., for spare parts for AN/FPS-16 instrumentation radars.

$200,000—**Perkin-Elmer Corp.'s Electro-Optical Division**, Los Angeles, for development of a miniature infrared spectrometer for airborne use.

$110,000—**The Martin Co.**, Baltimore, for study of the structural aspects of large hydrofoil ships.

$55,106—**Melpar, Inc.**, Falls Church, Va., for investigation of the use of solion devices as a new approach to accelerometer applications in guidance systems.

**Servonics, Inc.**, Alexandria, Va., for production of automatic tracking system for search radar. Amount not disclosed.

## ARMY

$56,894,827—**Raytheon Co.**, Waltham, Mass., for ground support, engineering services, radar sets, field service documentation and production of the *Hawk* missile system. (Five contracts.)

$19,185,449—**Western Electric Co.**, North Carolina plants, for an improved capability item in connection with the *Nike-Hercules* missile system.

$9,549,082—**Aerojet General Corp.**, Sacramento, Calif., for rocket motors for the *Hawk* missile.

$5,913,521—**Convair Division of General Dynamics**, Pomona, Calif., for continued development of the *Mauler* missile system.

$4,405,849—**Sperry Rand Corp.**, Salt Lake City, for product and production engineering services on the *Sergeant* missile system.

$4,000,000—**Electronic Defense Laboratories, Sylvania Electric Products, Inc.**, for a research and development project in the electronic warfare field.

$3,804,912—**The Martin Co.**, Orlando, Fla., for engineering services on the *Lacrosse* missile system.

$3,000,000—**The Martin Co.**, Orlando, for artillery training kits for ground support equipment for the *Pershing* missile system.

$2,458,071—**Food Machinery Chemical Corp.**, San Jose, Calif., for loader transporters and ramps for the *Hawk* missile.

$2,304,991—**Nortronics Division of Northrop Corp.**, Anaheim, Calif., for launchers for the *XM78-3* target missile.

$2,898,961—**Radioplane Division of Northrop Corp.**, Van Nuys, Calif., for *RP-76-3* target missiles.

$1,977,527—**Nortronics Division of Northrop Corp.**, Anaheim, Calif., for *Hawk* missile wing assemblies.

$1,075,913—**The Freuhauf Trailer Co.**, Los Angeles, for production of basic enclosure and trailer frames for the *Sergeant* system.

$833,000—**Sperry Utah Company**, Salt Lake City, for production of warhead components, missile containers and shop maintenance sets for the *Sergeant* missile.

$134,743—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike* missile system repair parts.

$47,827—**Gilfillan Bros., Inc.**, Los Angeles, for a prototype accessory set; $46,484 for *Corporal* missile system spare parts; and $27,171 for *Sergeant* missile telemetry equipment.

## AIR FORCE

**Minneapolis-Honeywell Regulator Co.** from **Boeing Airplane Co.**, Seattle, multimillion-dollar research and development contract for work on the *Dyna-Soar* manned space glider program.

$1,500,000—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for engineering and production of ground countermeasures receiving equipment.

$1,448,292—**Semiconductor Products Division of Motorola, Inc.**, from **Autonetics Division of North American Aviation, Inc.**, for high-reliability transistors to be used in inertial guidance, flight control and ground checkout equipment being produced for *Minuteman*.

$981,952—**Yardney Electric Corp.**, N.Y., for repair kits for *Bomarc* missiles.

$150,000—**American Machine & Foundry Co.**, Greenwich, Conn., for components and related ground support equipment for *Titan* launchers.

$100,000—**North American Aviation**, Downey, Calif., for storage of *GAM-77* missiles.

$20,000—**Tracerlab**, Waltham, Mass., for development of instrumentation to detect toxic gases at exotic fuel fabrication sites.

**Marquardt Corp.**, Van Nuys, Calif., from **North American Aviation, Inc., Space and Information Systems Division**, for continuing production of inlet control systems, components and spare parts for the *Hound Dog* missile. Amount not disclosed.

# reviews

**SPACE TRAJECTORIES**, edited by the technical staff of Radiation Div., Radiation Inc., Academic Press, New York, 298 pp., $12.

If the reader can ignore the uneven treatment of the subject—a usual condition when symposium papers are merely scooped up and thrust into a book—he will surely find some helpful material in the present text.

For example, Rudolf Hermann, University of Minnesota, does a good job surveying re-entry trajectories and problems of hypersonic flow; G. B. Westrom, Aeronutronics, presents a cohesive picture of trajectory constants; and there are other articles worth reading. Unhappily, some of them are only distant relatives to the field of space trajectories, the subject of the book

The papers resulted from a two-day symposium sponsored by the American Astronautical Society, the Advanced Research Projects Agency, and Radiation Inc. on Dec. 14-15, 1959, intended to cover the space trajectory field.

**ELEMENTS OF FLIGHT PROPULSION**, Joseph V. Foa, John Wiley & Sons, Inc., New York, 445 pp., $12.50.

Here is an excellent book on propulsion which disbelieves in nagging a technical problem to death. Instead, it treats general propulsion engineering concepts with conventional analytical tools but wielded with some originality and conciseness.

The book is meant to be used for creative work in the propulsion field and for evaluating new ideas. Thus, specific devices are discussed only to illustrate concepts and not merely to lead to a compendium of propulsion formulas.

Written by a professor of aeronautical engineering at Rensselaer Polytechnic Institute, the book is also recommended because of its extended treatment of non-steady as well as steady propulsion flows.

**MODERN MATHEMATICS FOR THE ENGINEER**, Second Series, edited by Edwin F. Beckenbach, McGraw-Hill Book Co., Inc., New York, 456 pp., $9.50.

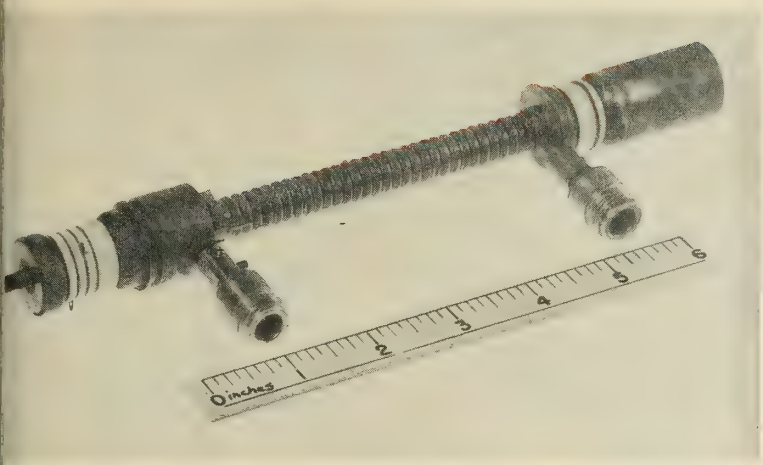
The material is divided into three parts: mathematical methods, statistical and scheduling studies, and physical phenomena. Each part includes contributions from some of this countrys' leading mathematicians.

Their intent was to give a broad survey of the applications of advanced mathematics to modern technology. Their papers are the result of a 1958-59 series of lectures conducted by the University of California, through University Extension.

In part 1, mathematical methods, involving operators in Hilbert space, distributions, transforms, semigroups, and asymptotic approximations, are put in perspective through applications to physical and engineering problems.

Part 2 is devoted to the modern probabilistic and statistical methods that are having such a strong impact on technology.

In part 3, the mathematical tools are applied through Monte Carlo methods matrix methods, and machine computation




## Miniature Amplifier

A miniature amplifier that will vastly increase the power output of future space satellite communication systems is available from the Sperry Gyroscope Co.

The amplifier—a traveling wave tube named the STX-182—is expected to produce up to 40 watts of power over an extremely broad frequency range in order to magnify simultaneously a great number of communications signals.

To generate the high output power, a unique electron beam focusing structure is employed to assure the exact aiming of highly concentrated electrical energy down the length of the tube. Tiny permanent magnets made of a special alloy are slipped over the tube, much like a row of precisely spaced finger rings, to form the focusing structure.

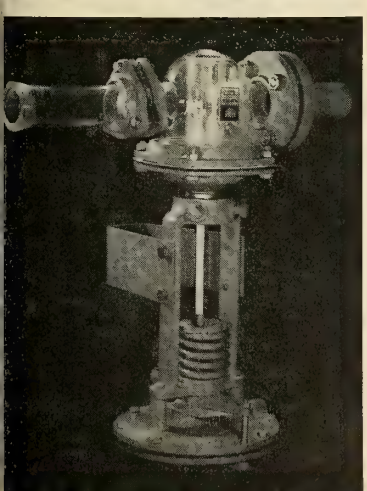
Circle No. 225 on Subscriber Service Card

## Throttling Valve

An air-operated throttling valve with Telfon diaphragm and a borosilicate glass body is available from Porter Engineering Co. The valve operates on standard 3-15 psig instrument air and can be used with either metal or glass pipe. It is fail-safe because air failure causes the valve to close completely. Both the setting of the diaphragm and flow through the valves are visible at all times.

The valve is recommended for handling all liquids except hydrofluoric acid and hot alkalies. It is effective from a vacuum of 10 mm. of mercury to 30 psig at an operating temperature of up to 400°F.

Circle No. 226 on Subscriber Service Card



## Thermal Protection Evaluator

A standardized, calibrated, high-temperature materials-testing apparatus for operation in the 30-200 KW power range, producing 10,000-mph gas streams with stagnation pressures ranging from 1 to 20 atmospheres, is available from Thermal Dynamics Corp. With this tester, it is possible to measure heat conduction and resistance in thermal shock and ablation environments ranging from that seen by the leading edge of high-Mach-number planes like the B-70 to that encountered by a re-entering missile nose cone like the *Atlas*. Emphasis has been placed on design of equipment which will give consistent reproducible results. The apparatus is calibrated prior to shipment against established standards, and the accessories furnished permit recalibration by the operator during tests.

Circle No. 227 on Subscriber Service Card

## Precision Regulator

Designed for operation with 6500 PSI systems, a lightweight pneumatic regulator operating at a constant outlet pressure is being marketed by Benbow Manufacturing Corp. Eleven outlet ranges are available from 0-60 psi 0-6500 psi.

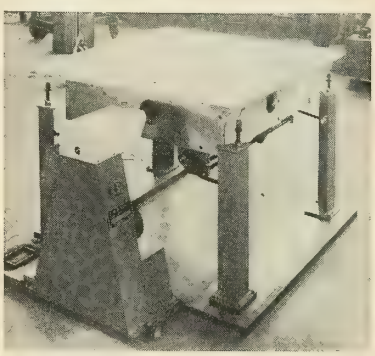
Guages are furnished at both inlet and outlet, and regulator is manually adjustable by a Lo-Torque hand control. An automatic relief provides system protection and a special ball-bearing guide insures accurate sensing.

Construction is simplified for easy field service.

Circle No. 228 on Subscriber Service Card

## Vibration Tables

Lightweight construction and low equipment cost are features of a series of vibration tables developed by the L. A. B. Corp. Developed specifically for reliability testing programs for electronic equipment, the vibration tables are available in two series—RH-5220 for horizontal vibration and RV-5340 for vertical vibration.



The machines produce simple harmonic table motion and employ the reaction principle of vibration, with the tables supported by spring and cable suspension systems. This feature isolates all vibrations from the floor and eliminates the necessity of concrete foundations to anchor the machine.

Circle No. 229 on Subscriber Service Card

## Lightweight Mirrors

Optical mirrors for airborne systems five to 10 times lighter than conventional optical parts are available from Precision Lapping Co., Inc.

Owing to a process which utilizes a honey comb cross-section of the mirror,

there is no sacrifice of rigidity or precision of the reflecting surface.

Recommended for shock-resistant applications, mirrors can be furnished as flats, spheres or aspherics in diameters up to 48 inches. Made of glass or quartz, these units will withstand temperature variations of −80° to +165°F.

Due to the low coefficient of expansion of fused quartz, it is possible to attach supports directly to the honeycomb base of the lightweight mirror, a new and simple design approach for supporting structures having to overcome g loads, vibration and thermal shocks.

Circle No. 230 on Subscriber Service Card

## Printed Board Connector

A device for connecting flat conductor cable to printed circuit boards or to flexible etched circuitry is available from The Thomas & Betts Co. Called POS-E-KON, the connector produces a direct conductor-to-conductor contact without solder. A continuous one-piece spring locks the cable into the connector. It provides a pressure point at each conductor contact.

In addition to its connector application, the device can be used to set up test points at any position on flat conductor cable. It can also be used to connect flat conductor cable to flat conductor cable without cutting conductors.

Circle No. 231 on Subscriber Service Card

## Pressure Relief Valve

Pressure build-up and burning rate of solid propellants used in a stores ejector system are controlled by a valve, Model PRV-29M, available from Marotta Valve Corp.

Features achieved from inverted-type relief valves are: freedom from premature leakage, freedom from chatter and oscillation, excellent regulation characteristics and compensation for minor pressure surges without loss of gas.

Circle No. 232 on Subscriber Service Card



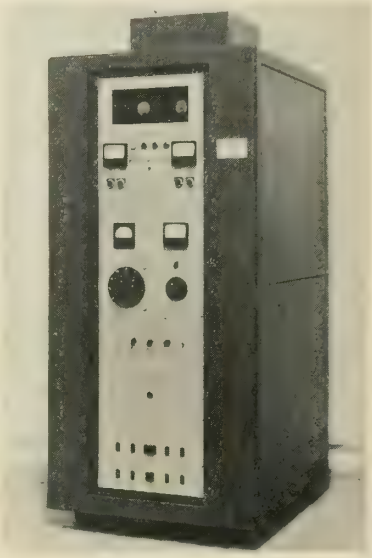
## Vertical Sensing Element

Kearfott Division, General Precision, Inc. is marketing the C70 1806 002 electromagnetic vertical sensing element, a gravity-sensitive, liquid-damped, pendulous device which can be applied to any vertical sensing situation requiring an electrical output. A frictionless wire-suspended mass acts as the moving portion of two orthogonally mounted differential transformers to provide a phase-sensitive output signal proportional to tilt angle.

Circle No. 233 on Subscriber Service Card

## Pulse Modulator

A versatile pulsed-power signal-source modulator with peak power of 1.2 megawatts has been introduced by Radiation Inc.



The self-contained Model 344M was specially designed for pulsing klystrons, traveling wave tubes, or magnetrons. The trigger generator, pulser, high-voltage power supply and filament supply for the tube under test are contained in a single seven-ft.-high cabinet. Meters are provided for power supply, voltage, power supply average and local currents, filament voltage and current for the tube under test. A high voltage pulse voltage divider monitor is included.

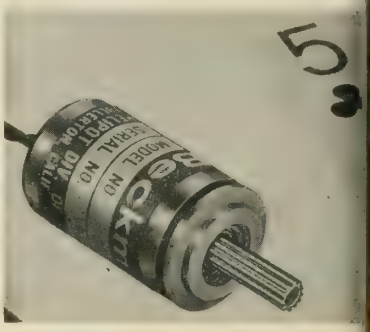
Circle No. 234 on Subscriber Service Card

## Size 5 Servomotor

Helipot Division of Beckman Instruments, Inc. is commencing production of Size 5 servomotors.

The servomotor, designated Model 9005-1502-0, is only 0.865 in. long Weight of this precision control component is 0.6 oz. Powered by 26-volt 400-cycle reference voltage, the servo motor has a no-load-speed of 10,000 rpm. Torque-at-stall registers 0.1 oz. in. while rotor inertia is 0.18 gm.cm$^2$, providing an acceleration-at-stall of 39,000 rad/sec$^2$.

Circle No. 235 on Subscriber Service Card



## Compact Telemetry Receive

Vitro Electronics, a Division o Vitro Corp., is adding to its line o Nems-Clarke Telemetry Receivers compact, lightweight precision receive for FM, AM and CW signals in th 30 to 260 mc range.

This receiver features an AM Nois Limiter adjustable from the front pane and a carrier operated relay to provic automatic carrier-on, carrier-off oper tion of auxiliary equipment through tw contacts provided for that purpose. Th action is indicated by a panel light.

Circle No. 236 on Subscriber Service Card

## Smallest Hermetic Diodes

Two microminiature glass diodes a are available from Texas Instrumen Inc.

These components, designate "MICRO/G(TR) diodes," have packag diameter of 0.040 in., length of 0.0 in., and round leads providing a redu tion in volume of 50:1 over conve tional diodes with similar characteristic

The two new devices being offere the TI-2 and TI-6, are computer diod which capitalize on diffused silicon me wafers whose surfaces have been oxid passivated for optimum stability a reliability.

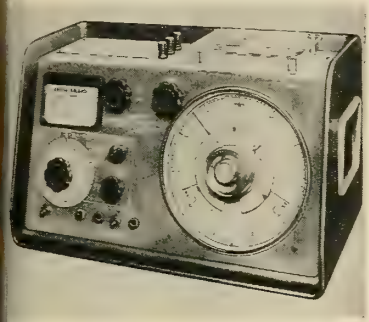
Circle No. 237 on Subscriber Service Card

## Universal Bridge

Marconi Instruments has available Universal Bridge Model 1313 whi measures L to 110H, C to 110μF a R to 110MΩ, all with ¼% accurac Measurments may be made at 1 a 10Kc with an internal oscillator throughout the audio range with e ternal source and detector. Readout

irect without use of multiplication actors. A unique feature is the main alance control, whose 140 discrete eps eliminate the conventional balance otentiometer. An interpolation control djusts for final balance to ¼% accuracy.

Circle No. 238 on Subscriber Service Card



## Sensitive Magnetometer

An extremely sensitive, lightweight, nd compact magnetometer, capable of neasuring the minute magnetic anomlies encountered in space, underwater nd subterranean studies, has been deeloped by Arnoux Corp.

Suitable for detecting magnetic nomalies of 0.1 gamma or less, the nagnetometer relays data in digital or nalog form. The device can measure nagnetic fields of the earth, planetary odies, fields in the ionosphere and leep space, from solar and extraystemic sources. The continuous signal has sufficient amplitude to feed data lirectly to telemetry systems or reorders. Featuring low power consumption of 0.8 watts at 200 ma from a + vdc source, the cylindrical unit is 7 in. ong, 3 in. wide, but smaller models re available.

Circle No. 239 on Subscriber Service Card

## Band Pass Filters

Miniature band pass filters designed pecifically for use with telemetering ystems and other transmission applicaions are available from Telonic Engineering Corp.

Filter characteristics such as center requency, bandwidth and cutoff may e varied to meet individual requirements. Center frequencies are available overing the 200 to 2000 mc region with band pass widths of 2.5% to 20%.

Features of the TBP filters are small ize and ruggedness. Their diameter is nly slightly larger than the BNC connectors at each end. Other standard connectors are also available. Design is based on that of a lumped-constant filter with capacitance obtained by close-tolerance teflon and silver-plated brass sections. Coil forms and spacers are temperature-resistant, enabling operation at temperatures over 100°C.

Circle No. 240 on Subscriber Service Card

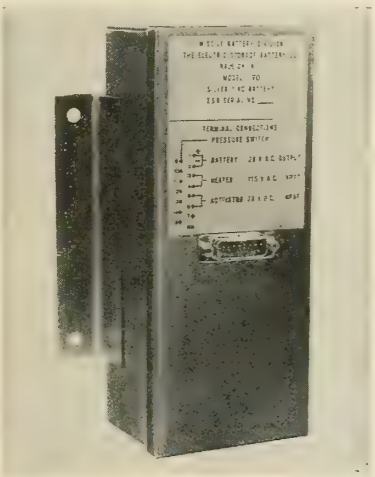
## Helium Leak Detector

A high-sensitivity, dual-range helium detector that permits quick and precise location of helium leaks in tanks, piping and other fittings is available from Industrial Instruments, Inc. The two-range feature permits high sensitivity pickup of small leaks while minimizing overdrive of the meter on large leaks. The thermal conductivity sensitivity detector is powered with mercury cells, assuring long battery life. The unit includes a "transport position" on the range selector switch to short out the meter movement during transportation.

Circle No. 241 on Subscriber Service Card

## Automatic Battery

A silver-zinc primary battery that will activate itself within a maximum of 15 seconds has been developed as



an electrical power source for missiles by the Missile Battery Division of The Electric Storage Battery Co.

Designed to provide ample power needed to transmit data from long distances, the 28-volt ESB Model 70 battery will discharge for 12 minutes with an electrical load of 5 amps. The voltage is regulated to limit fluctuation to ±5.4% of the 5-amp load.

Electrical capacity of the battery is one ampere-hour at the one-hour rate of discharge. It delivers 6.65 watt-hours per pound or 0.48 w/hr/in.$^3$

Circle No. 242 on Subscriber Service Card

## Cathode Ray Tube Console

Automation Laboratories, Inc. has available a universal test console that can evaluate the performance of electrostatically and electromagnetically deflected direct-view storage and cathode ray tubes up to 30 in. long. The console design features include the capability of evaluating present and anticipated future storage tube characteristics.

The console, designated as Model 300B Universal Storage and Cathode Ray Tube Console, can test storage tubes having up to two writing guns and one flood gun. A central main control compartment allows an operator to readily control, record, and observe the characteristics of storage tubes.

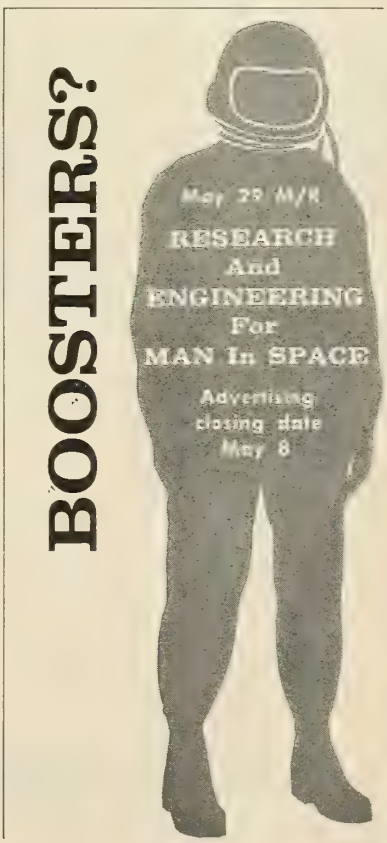
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## Digital Transducers

DeJur-Amsco Corp. has developed a complete line of digital transducers with true digital outputs. These devices reduce the overall size of instrumentation and control systems, increase their reliability and produce results which can be directly stored and used in digital computers.

Important features which characterize this digital transducer is its ability to sense different sources of energy in one miniature selfcontained package, and deliver a true digital signal output directly proportional to the amount of energy monitored. Also, its solid-state circuit configuration makes this transducer relatively impervious to ambient environmental variations.

Circle No. 244 on Subscriber Service Card

## Booster Initiative

*To the Editor:*

I wish to congratulate M/R for supplying such comprehensive coverage of this fascinating and rapidly developing sphere of endeavour.

Consideration of the present and proposed U.S. space plans leads me to put forward a few observations for readers' consideration.

In a recent issue of *The New Scientist* (5-1-61), Professor A. D. Baxter of de Havilland Engine Co. Ltd., England, in his article "Towards Giant Space Vehicles," produces a very interesting graph comparing the increase of payloads in orbit put up by U.S. and U.S.S.R., with time. This graph shows the Soviet curve to be consistently higher. The projected boosters *Saturn* and *Nova*, although lying on the U.S. curve, do *not* cause the U.S. curve to cross the extended Soviet curve.

Another point which is becoming obvious is that future orbital and planetary stations will need massive thrust boosters. These boosters seem to be missing from the U.S. programme. The U.S.S.R. has set 1967 (fiftieth anniversary of the 1917 revolution) to get a man on the moon. If they plan this, then boosters in the 5-10 million-lb.-thrust range must now be on the drawing board, if not already in development. Surely the proposal to develop such boosters as *Atlas G* and *Titan III* of 8-9,000,000 lbs. thrust (probably the same as present Soviet space boosters) is no way to take a lead in the "space race," especially as *Saturn* is almost ready for its first launch.

Through this apparent gloom I have detected one or two bright gleams of far-reaching thought. Firstly, in M/R, Oct. 31, 1960, p. 38, a suggestion is made that segmented solid boosters of up to 20 million lbs. thrust could be developed on present know-how. Secondly, a more detailed suggestion was made by Messrs. H. L. Thackwell and R. M. Pierce in M/R, Dec. 12, 1960, p. 35, in which they propose multistage solid boosters of from 7 to 21 million lbs. thrust for orbiting up to 130 tons. They also suggest that these boosters could be ready for use by 1964-66. Surely it is this type of thinking and planning that will give the U.S. the initiative. The advantages of this type of boosters are attractive:

a) Low cost per lb. of payload.
b) Flexibility in construction.
c) Can be ready soon.

Along with the development of these boosters, an equally intensive development programme should be conducted in the design and astromedicine of space vehicles and stations.

The success of *Polaris, Minuteman* and experimental segmented rockets should give the designers confidence.

If I may be permitted I would sugges the following points:

1) Acceleration of *Saturn* with the us of existing boosters as second stages fo orbital flights with first-stage trials. Thi would put heavy earth satellites into orbi and regain lost prestige.

2) The immediate design and devel opment of solid boosters of the rang from 5-20 million, for orbital flights b 1964-66.

3) Concentration of *all* available re sources on this project, and elimination o all duplication in work.

4) Parallel design and development i the fields of space vehicles, support equip ment and space medicine.

If imaginative projects are initiated an pressed ahead, an American could be th first man on the moon, or even Mars.

Again, thanks for your excellent pub lication. I hope my observations will stimu late readers' thought.

C. P. Wilson
113 Sunderland Road, Forest Hi
London S.E. 23, England

## Recalling Lenin

*To the Editor:*

I take the liberty of writing with re spect to the very striking and timel advertisement published in M/R, Jan. 3 p. 53, sponsored by Microdot Inc. (quotin Lenin's "We have never rejected terror o principle . . .").

I would like to thank you for the cou age shown by your publication in punchin back the communists with their own n farious words. As a chemist who reac extensively the technical literature, I wa very pleasantly surprised to see such stat ments for the first time in a scientific per odical. I have shown the advertisement t several technical and nontechnical peop and they all join me in thanking you fo such an effective display of the truth an in asking at the same time that you pri more such advertisements. Communist li erature and pronouncements are full statements as to the way our way of li is doomed and of how they plan to de with us, hence there is no danger that yo publication and advertisers will run o of ideas or quotations.

Senta S. Rogers
Washington, D.

## What the Jell

*To the Editor:*

You are careless. First you define ar give the correct pronunciation of an Au tralian aboriginal name ("Boom Is on Australia's Woomera Range," M/R, Mar 27, p. 43). Then (in the same article) y goof and locate the Goldstone transmitt in the "Mohave" Desert. Tsk, tsk.

Daniel K. Tillman
Corona, Calif.

*A rather fine point. "Mojave" is t official name; "Mohave," which is al frequently used, is acceptable according Webster's New Collegiate Dictionary—E*




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Aerojet-General Corp., Sub.-General Tire & Rubber Co.... 52
Agency-D'Arcy Adv. Co.

Autonetics, a Div. of North American Aviation, Inc..... 4
Agency—Batten, Barton, Durstine & Osborn, Inc.

Bell Aerosystems Co., a Div. of Bell Aerospace Corp..... 2
Agency—The Rumrill Co., Inc.

Delco Radio, Div.-General Motors Corp. ..... 3
Agency—Campbell-Ewald Co.

Engelhard Industries, Inc..... 48
Agency—Stuart Sande, Adv.

Grand Central Rocket Co..... 12
Agency—Foote, Cone & Belding

Kearfott Co., Sub.-General Precision Equipment Corp..... 11
Agency—Gaynor & Ducas, Inc.

Lockheed Aircraft Corp., Missiles & Space Div..... 20
Hal Stebbins, Inc.

Martin Co., The..... 51
Agency—Ketchum, MacLeod & Grove, Inc.

Northrop Corp. ..... 8, 9
Agency—Doyle, Dane, Bernbach, Inc.

Rocketdyne, a Div. of North American Aviation, Inc..... 33
Agency—Batten, Barton, Durstine & Osborn, Inc.

Ruska Instrument Corp..... 49
Agency—Rives, Dyke & Co., Adv.

Space Technology Labs., Inc., Sub. of Thompson Ramo Wooldridge Corp. ..... 6
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**Six Lectures on Synthesis of Intelligent Behavior, sponsored by Institute of Radio Engineers (IRE), and Society for Industrial and Applied Mathematics (SIAM),** University of Pennsylvania, Philadelphia, meeting weekly April 10-May 15.

**ASME Maintenance and Plant Engineering Conference,** Bancroft Hotel, Worcester, Mass., April 10-11.

**The Combustion Institute, Western States Section,** Aeronutronic Division of Ford Motor Co., Newport Beach, Calif., April 10-11.

**Cincinnati Sections of the Society for Applied Spectroscopy and Instrument Society of America Symposium,** Cincinnati Gardens, Cincinnati, April 11-12.

**Air Force Office of Scientific Research, Conference on Ultrapurification of Semiconductor Materials,** New England Mutual Hall, Boston, April 11-13.

**Symposium on Information and Decision Processes,** Purdue University, Lafayette, Ind., April 12-13.

**Cincinnati Section IRE, with Southern Ohio Section of American Rocket Society, 15th Annual Spring Technical Conference, Electronic Data Processing,** Hotel Alms, Cincinnati, April 12-13.

**Institute of the Aerospace Sciences, Army Aviation Meeting (classified),** Washington, D.C., April 13-14.

**Seventh Military Operations Research Symposium, ONR,** Boeing Airplane Co., Seattle, April 17-19.

**Seventh National Instrument Society of America, Symposium on Instrumental Methods of Analysis,** Shamrock-Hilton Hotel, Houston, April 17-19.

**Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute,** Mark Hopkins Hotel, San Francisco, April 18-20.

**Bureau of Naval Weapons Missiles and Rockets Symposium,** U.S. Naval Ammunition Depot, Concord, Calif., April 18-21.

**American Geophysical Union, and American Meteorological Society, Annual Meetings,** National Academy of Sciences, Washington, D.C., April 18-21.

**13th Annual Southwestern Institute of Radio Engineers, Conference and Electronics Show (SWIRECO),** Dallas Memorial Auditorium, April 19-21.

**American Society of Mechanical Engineers, Metals Engineering Conference, sponsored with American Welding Society,** Pennsylvania Sheraton Hotel, Pittsburgh, April 23-26.

**Symposium on Structural Dynamics of High Speed Flight (confidential), Aerospace Industries Association and Office of Naval Research,** AIA Auditorium, Los Angeles, April 24-26.


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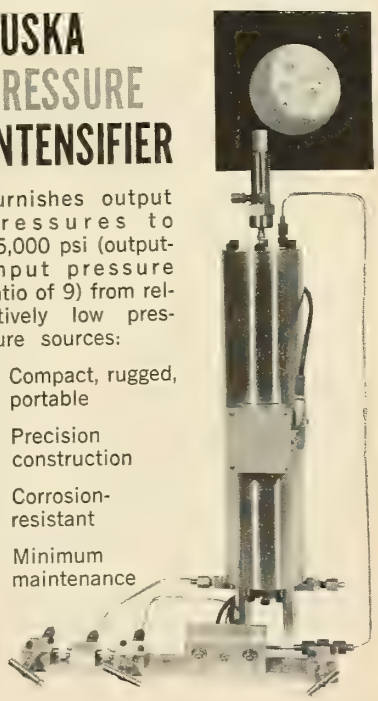
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## editorial . . .

# Basing Contract Awards on Merit

PRESIDENT KENNEDY'S proposal to step up *Minuteman* output by doubling production facilities in existing contractor plants is a welcome one.

There had been talk of going to second sources for the production increase. Although this would have had the advantage of spreading the honey around a bit, it would have been uneconomic.

For some of the *Minuteman* electronics, it may still be necessary to seek a second source. But, for the most part, even the existing facilities have not yet been pushed to capacity.

Beyond this, the most efficient way to step up production is to provide additional facilities at those plants where the program already is under way. There have been cases—a notable one recently—where second-sourcing was used as a means of cost reduction. But, in general, there is no cheaper way to expand output than to do it in the plant already geared up for it.

Experience is a mighty powerful money saver. Learning curves apply not only to production line workers but to management. One of the strongest points of U.S. industry has been its ability to decrease cost with an increase in unit output.

Cost factors on *Minuteman* already have gotten out of hand. Less than a year ago, top Air Force officers were talking of *Minuteman* as the "cheap" missile, estimating its cost in the hole ready to go as one million dollars per missile. They would be happier today if everyone would forget those estimates. Final cost may turn out to be closer to two million dollars each.

Air Force now is weighing the possibilities of the smaller *Midgetman* as a truly cheap missile. But, whatever the fate of *Midgetman*, anything done to hold down costs in the big *Minuteman* program is an important move.

For that reason, the decision to expand the program in the plants already holding contracts is a wise one. It obviously is not as politically attractive as a decision to go to second sources would have been. The temptation to throw some of the *Minuteman* business into so-called "depressed areas" must have been a strong one.

This question of using military contracts as a social tool to soften economic hardship in various parts of the country comes up periodically. It is a question to which there should be only one answer—"Never!"

Contract awards ideally should be based on technical quality of bids and past performance of the competing companies in meeting delivery dates and cost estimates. Anyone who thinks political pressure does not play a large role, however, is a starry-eyed idealist. It is imperative for every administration to resist this pressure to the greatest extent possible.

Unfortunately, this seems to have been forgotten in recent years. The unsightly scramble of major missile/space companies to prove that they are in a more depressed area than their competitors has been one result.

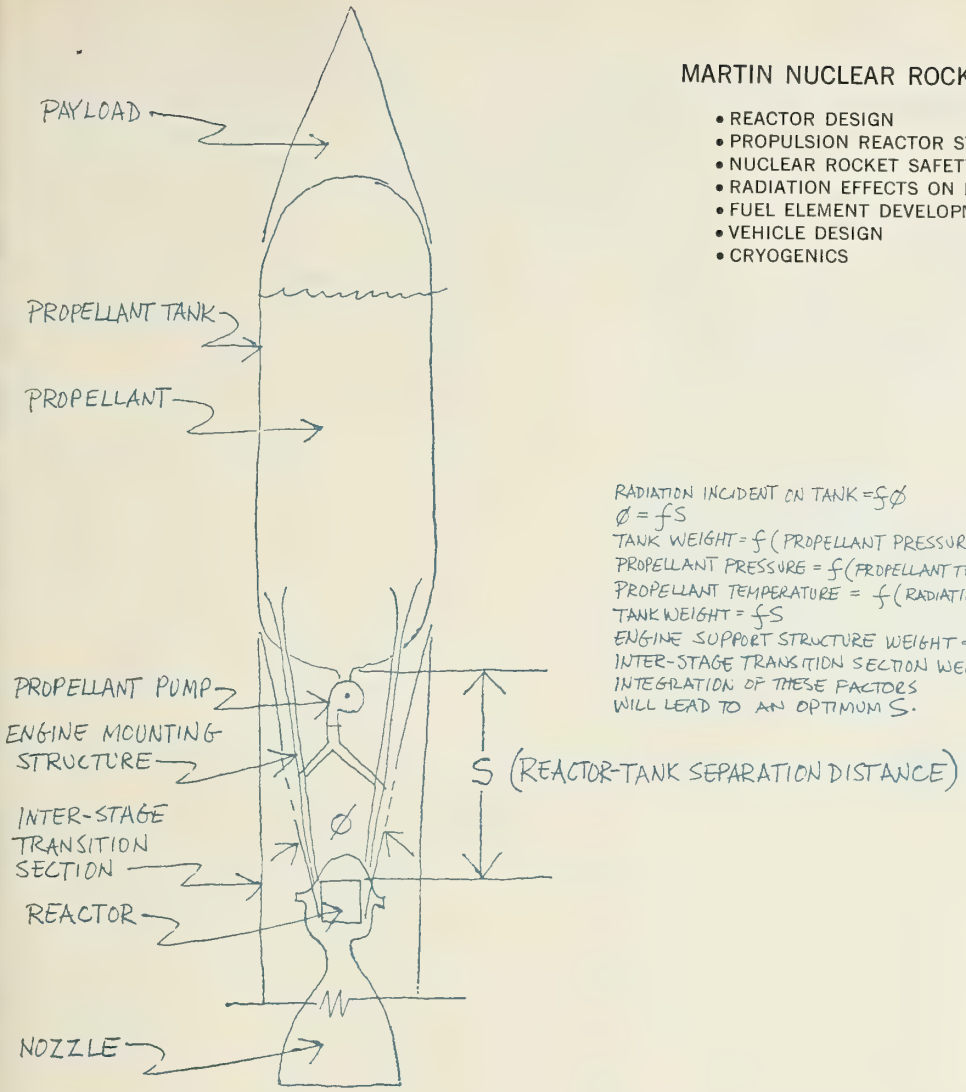
THERE ARE STRONG arguments against this depressed area philosophy. For one, any factor that operates against minimum costs in a military program puts us one down in the economic war with the Soviet Union. For another, any influence working against maximum technical quality within the minimum cost margins is wholly bad.

Too often it is forgotten that while the prime contractor may not be in a depressed area, subcontracts from that firm may be going to several depressed areas. The political scramble then can become fierce.

Recently, the manager of a medium-sized electronics firm was asked what his major problem is these days. His reply—"Outguessing the politicians." He went on to point out that far too many contract awards now depend on politics, rather than merit. Then he added—"I'm a Republican but I must admit it got a good deal worse under the last administration."

If the decision on the *Minuteman* program is an indication the present administration intends to reverse the trend, we are all for it. We hope Congress will take the same view.

**William J. Coughlin**

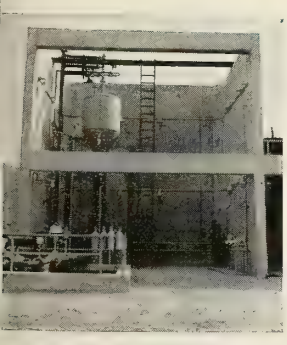



## MARTIN NUCLEAR ROCKET PROGRAM

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RADIATION INCIDENT ON TANK = $f\phi$
$\phi = fS$
TANK WEIGHT = $f$ (PROPELLANT PRESSURE)
PROPELLANT PRESSURE = $f$ (PROPELLANT TEMPERATURE)
PROPELLANT TEMPERATURE = $f$ (RADIATION ON TANK)
TANK WEIGHT = $fS$
ENGINE SUPPORT STRUCTURE WEIGHT = $fS$
INTER-STAGE TRANSITION SECTION WEIGHT = $fS$
INTEGRATION OF THESE FACTORS WILL LEAD TO AN OPTIMUM S.

# THE PROBLEM OF RADIATION HEATING IN NUCLEAR-POWERED ROCKETS



Martin liquid hydrogen test facility at Denver where heat transfer experiments are carried out.

The first flight of a U.S. nuclear rocket is targeted for the mid 1960's; but the achievement of this objective will depend upon the successful solution of many complex technical problems. At Martin, we are investigating all the areas listed above in a coordinated program designed to help solve these problems. An example of one approach to a problem area is illustrated. It concerns the propellant temperature elevation and excessive evaporation that might result from intense radiation created by the reactor.

Martin engineers at Baltimore and Denver are working on several approaches to the solution of this problem: 1) separation between the reactor and the propellant; 2) continuous cooling of certain components by the cryogenic propellant; and 3) shadow-shielding of propellant and components. Optimum solution appears to involve a combination of these alternatives, and can have a substantial influence on overall rocket system weight and performance.

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# missiles and rockets

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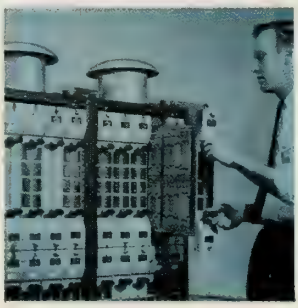
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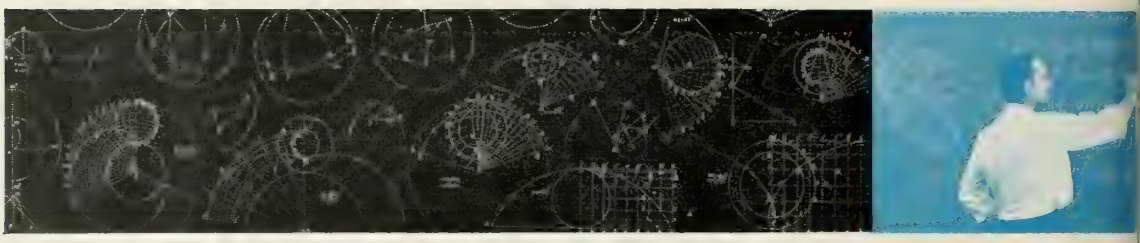
*First Man in Space— Russia's Yuri Gagarin*

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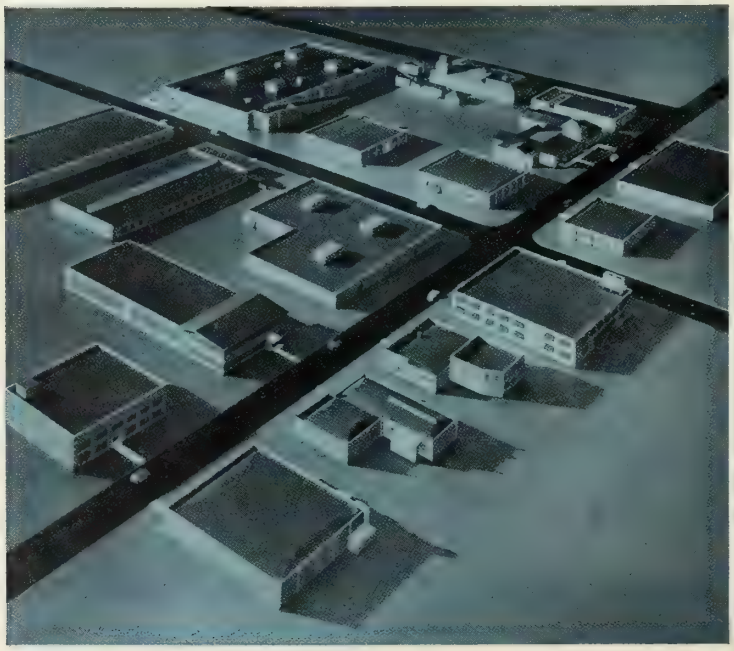
# LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities wher a variety of computer systems are currently in different stage of design and production. Some are strategically involved wit national defense...others deal with business and industrial proce control. Each is uniquely designed to answer a particular need. Th success of these systems illustrates the value of Librascope engineering philosophy: A decentralized organization of sp cialized project teams responsible for assignments from concept t delivery...and backed up by excellent research, service, and production faci ities. For your computer requirements, call on the company whose breadt of diversification in computer technology is unsurpassed. ■ Librascop Division, General Precision, Inc., 808 Western Avenue, Glendale, Cali For career opportunities write to John Schmidt, Engineering Employment.





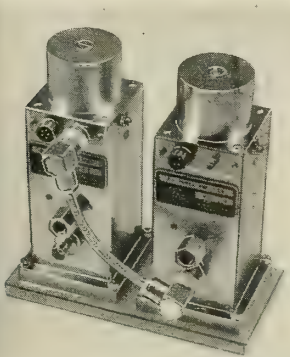
*computers that pace man's expanding mind*



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# Microdot Expands Telemetry Capability

South Pasadena — Microdot Inc. has recently acquired Spectralab Instrument Co. of Monrovia, California. The acquisition provides Microdot's Instrumentation Division with outstanding capabilities in the field of VHF and UHF cavities and related instrumentation. Spectralab has been widely noted for its recent scientific breakthrough in the new UHF telemetry field with the first operational UHF telemetry transmitter, and for its high power transmitter designed for the Pioneer V satellite. Spectralab instruments have also flown in the Redstone, Jupiter, Atlas and Pershing missiles.



**The Pioneer V transmitter shown above is typical of the sophisticated instrumentation now offered by Microdot. This miniaturized unit features an output of 150 watts, ease of adjustment, and proven outer space reliability.**

With the Spectralab acquisition, Microdot's telemetry capability now includes a broad product line ranging from sensing devices through transmitters. As a single source for instrumentation, Microdot can provide weldable strain gages, load cells, temperature probes, thermocouples, amplifiers, power supplies, signal conditioning equipment, power amplifiers, frequency doublers, oscillators and transmitters.

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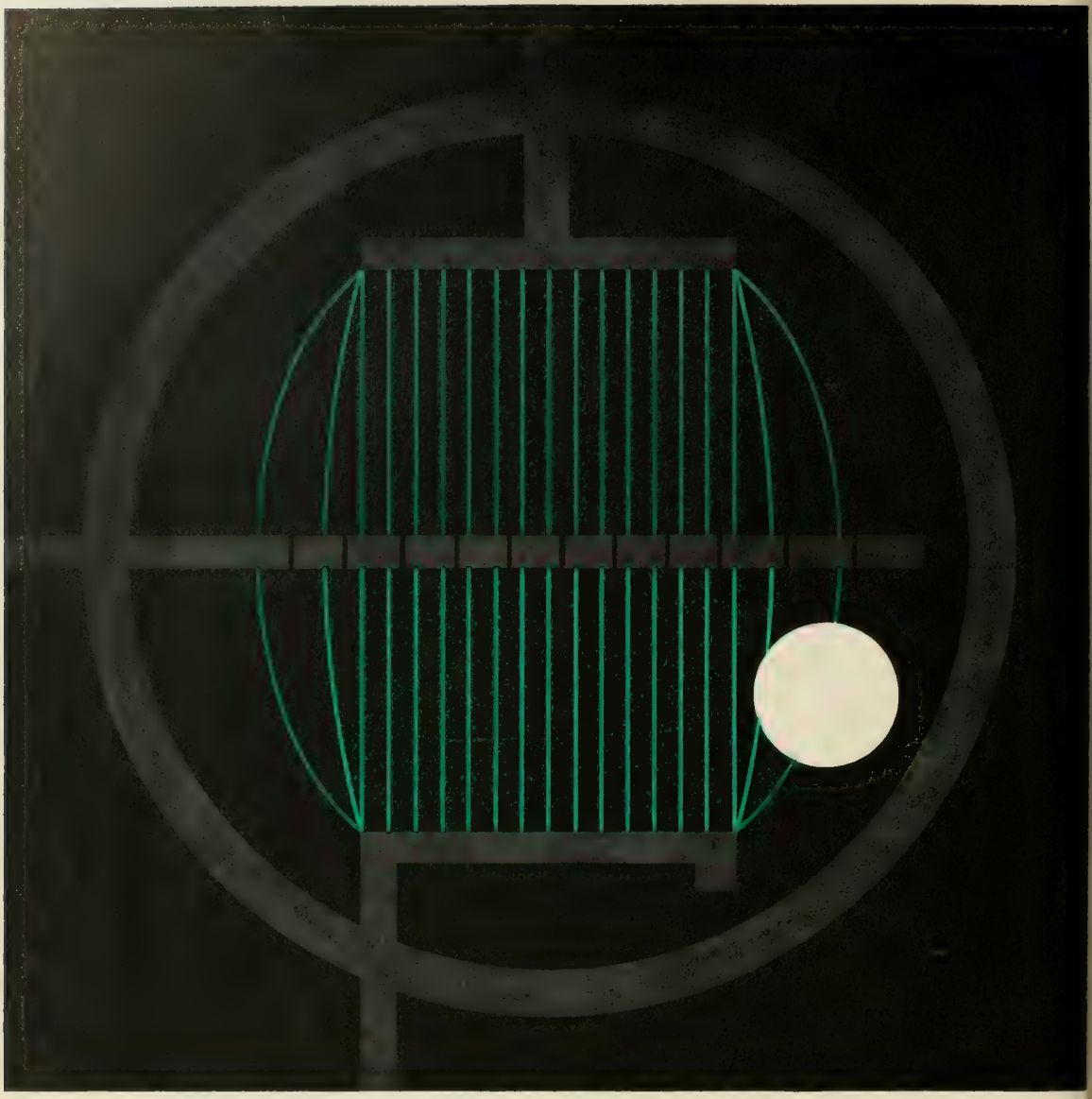



## "MAKE A NOISE IN THE EAST, BUT STRIKE IN THE WEST"

Mao-Tse-Tung's arsenal is impressive: 700-million expendable people. And soon, nuclear capability.

To those of us in the defense business the prospect is worthy of sober consideration. We cannot match Red China in expendable human lives. Instead we must rely upon the effectiveness of our defense capabilities to keep fingers off buttons.

The responsibility is clear. The real business of the defense business is survival.



# Electronics at Boeing

Electronics, symbolized by this diagrammatic representation, is a rapidly expanding field of activity at Boeing. Here engineers and scientists are at work in research, design and test areas of electronics. Activities cover a broad spectrum, from advancement of the state-of-the-art to the development, manufacture and installation of electronic systems.

Boeing scientists and engineers are also advancing the state-of-the-art in many other areas, including military jet aircraft, commercial jet transports, hypersonic flight, helicopters, vertical and short take-off and landing aircraft, gas turbine engines, space systems, antennas and hydrofoils. In addition, scientists of Boeing's Allied Research Associates subsidiary developed techniques and interpretive methods to analyze data transmitted to earth by Tiros I and Tiros II meteorological satellites.

## Professional-Level Openings

*Engineers and scientists and professional specialists in business and management disciplines will find career opportunities of unusual scope and potential at Boeing, as well as a stimulating environment conducive to rewarding achievement and rapid advancement. Drop a note now mentioning degrees and major, to Mr. John C. Sanders, Boeing Airplane Company, P.O. Box 3822-MIL, Seattle 24, Washington.*

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

Volume 8, Number 16 April 17, 1961

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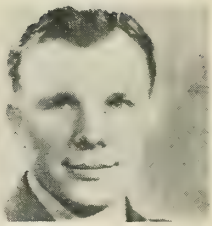
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## THE COVER

*Soviet Air Force Maj. Yuri A. Gagarin, first man to break through the space barrier, orbit the earth and return safely. (UPI radiotelephoto). See report on p. 14.*



## APRIL 17 HEADLINES

### REPORT ON RUSSIA'S MAN-IN-SPACE ACHIEVEMENT

Was the Vehicle a Winged Military Prototype? ..... 14
Sequence of Red Shots Shows Single Purpose ..... 16
Small Hope Seen for Big Mercury Atlas Speedup ..... 16

Syndicate May Operate Communication Satellites ..... 17
First Biochemical Fuel Cell Developed by U.S. ..... 18

## ELECTRONICS

Magnetohydrodynamics Tests Exceed Expectations ..... 23

## ASW ENGINEERING

Gaseous Envelopes May Increase Torpedo Speed ..... 26

## ADVANCED MATERIALS †

Solar Flare Knowledge Can Cut Vehicle Shielding ..... 31

## SPACE MEDICINE

GE Impacts Mice to Plot Astronaut Survival Hopes ..... 35

## SUPPORT EQUIPMENT

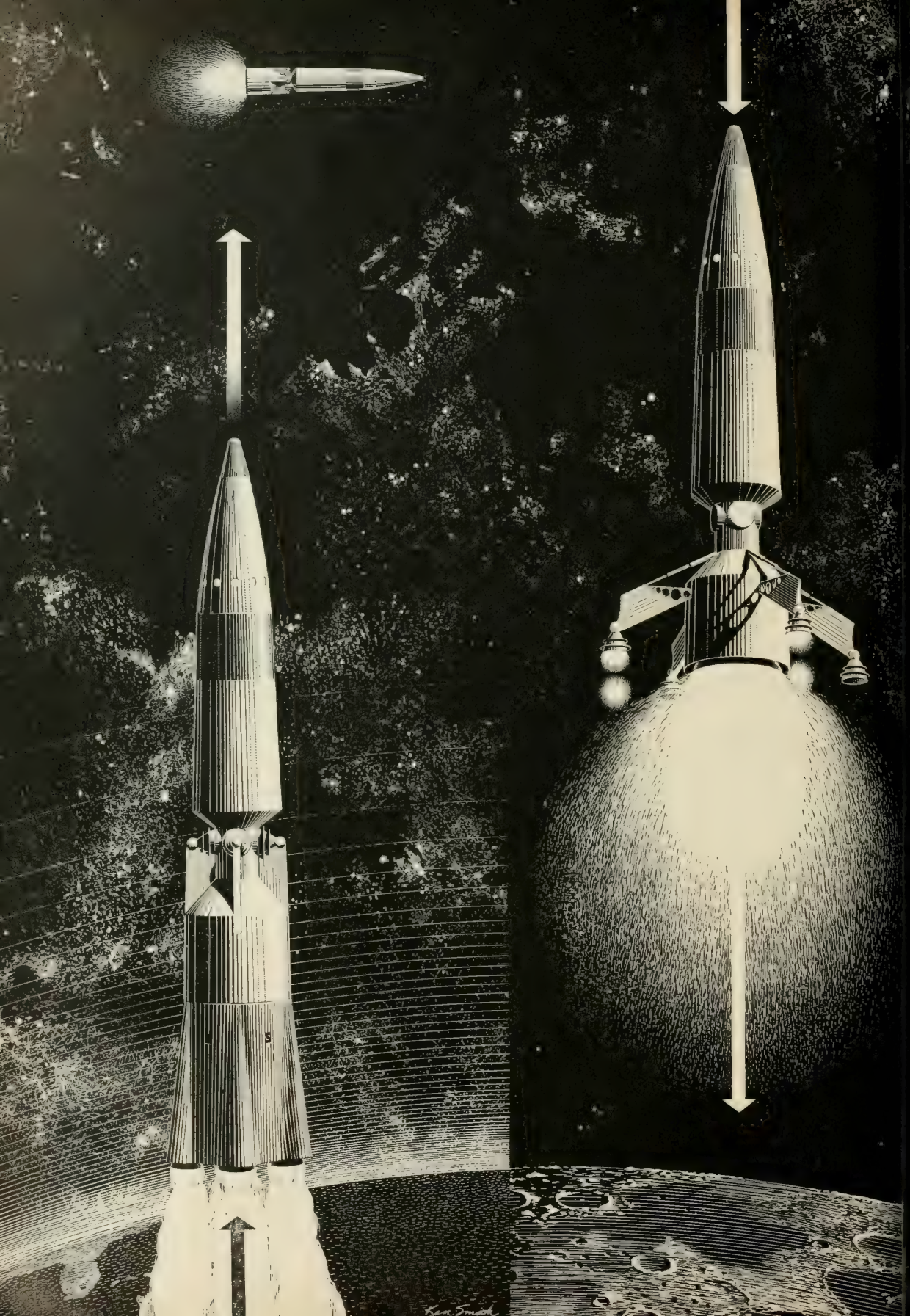
First Minuteman Emplacement Will Take 4-6 Hours ..... 40

## DEPARTMENTS

Letters ..... 9
The Countdown ..... 11
The Missile/Space Week † ..... 13
Technical Countdown ..... 21
Names in the News ..... 46
Products & Processes ..... 48
Contracts ..... 50
When and Where ..... 51
Reviews ..... 52
Editorial ..... 54

† U.S. Reg. Pdg.

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# MARQUARDT ROCKET ENGINES SPAN THE POWER SPECTRUM

## Recently developed throttleable engine capable of 250,000 pounds of thrust

A large rocket engine burning high-energy boron fuel and a storable oxidizer has demonstrated the highest performance ever attained with storable liquid propellants. In a static test firing the engine operated at 98% efficiency using a combustor design developed from high-energy fueled ramjets. The tests — part of a program sponsored by the Air Force — although limited to 100,000 pounds of thrust, proved an operational capability exceeding any ever attained with storable liquid propellants in large scale firings.

The concept of Energy Management[1] as applied to a variety of space systems requires rocket engines with throttling and restart capabilities. Marquardt liquid rocket engines share the following distinct advantages: throttleable rocket performance; ability to be restarted at altitude; near theoretical maximum performance; scaling by multiplicity; no regenerative cooling.

Marquardt has also achieved significant performance results in the development and testing of liquid rockets in the low and intermediate thrust range — from one pound to 15,000 pounds. These rockets are throttleable over a wide thrust range with no efficiency drop-off (see C* efficiency graph shown at right).

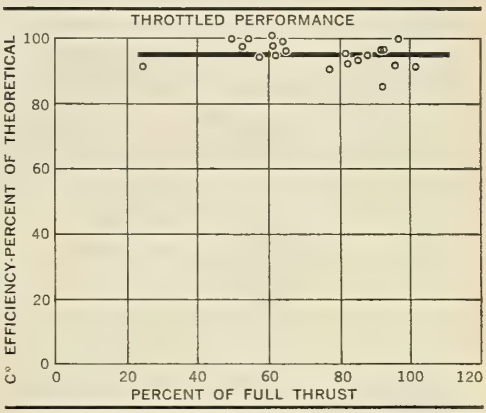
Radiation cooled rockets can be controlled accurately down to a few milliseconds in duration — as low as 0.003 pound-seconds impulse bits. A radiation cooled rocket motor has operated for over 23 minutes at a thrust efficiency of 90%. This design has demonstrated reliable ignition at $10^{-5}$ mm of mercury.

The development of rocket power plants of advanced design and near theoretical maximum performance is based upon sixteen years of experience and leadership in the propulsion field. Successful participation in and direction of more than 100 major high-altitude research rocket programs including the Explorer VIII and Vanguard satellite launching programs lend further support to Marquardt's leadership in the propulsion field. Capabilities in the research rocket area range from solid propellant rocket motor design and fabrication through final data reduction and information presentation.

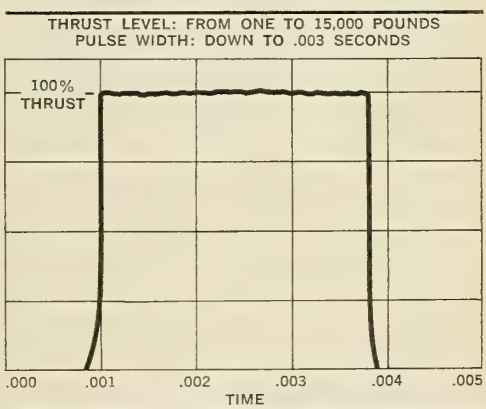
For information concerning Marquardt propulsion systems contact Don L. Walter, Vice President, Power Systems Group.

Scientists and engineers experienced in the fields of advanced propulsion devices are invited to investigate exceptional career opportunities with The Marquardt Corporation.

[1]*Energy Management — The technique of programming the use of stored chemical energy in a space system for maximum performance.*




**VARIABLE THRUST ROCKET ENGINE**
A typical group of rocket test firings using storable liquid propellants prove an average C* efficiency of 95% over a wide throttling range.




**DOCUMENTED IMPULSE CAPABILITY**
The above trace represents one impulse bit — demonstrating controllability of pulse width down to .003 seconds.

THE Marquardt CORPORATION
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# Min-K® soars through space –and back!

**J-M INSULATION, WITH k LOWER THAN THE MOLECULAR CONDUCTION OF AIR, SHIELDS AGAINST EXTREMES OF HEAT AND COLD**

As the Mercury Space Craft is launched, orbits and is recovered, exterior temperatures range from around –100F to plus 1600F. Yet, only inches away, inside the space vehicle, temperatures never fall below or exceed comfort and health levels. The reason? Two Johns-Manville insulations, selected by McDonnell Aircraft Corporation and the NASA, are doing their job to perfection. They are the *only* thermal insulations used in the space craft.

One of these is Min-K, the super insulation for critical areas. This unique material exhibits a marked reduction of thermal conductivity as atmospheric pressure decreases. Min-K also possesses a thermal diffusivity lower than ordinary materials which weigh five times as much. Thus it is possible to control thermal transients at a fraction of such weights.

For other sections of the Space Craft, where controlled heat flow was necessary, J-M Thermoflex RF Felt was used. Together, the Johns-Manville insulations make up a team that helps solve the space travel problem.

Solving insulation problems is a Johns-Manville specialty. For assistance on *your* problems, detail on Min-K and other J-M aviation insulations, write J. B. Jobe, Vice-President, Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

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# letters

## Close More Doors

*To the Editor:*

I have just read your editorial, "An Open Purse and a Shut Mouth" (M/R, March 20, p. 50).

I heartily endorse your stand and opinions.

More doors at technical meetings should be closed to the Russians. We are foolish to give them all the information and knowledge we have developed. I am quite sure they don't give us all or any secrets or skills.

B. John Skawinski
Waterford, Conn.

## Sub Simulator Batteries

*To the Editor:*

In view of the increasing importance of developments in the field of antisubmarine warfare, you and Mr. Beller are to be congratulated on your fine article, "Navy Getting Sub Target Simulators" (M/R, March 3, p. 28).

We feel very strongly, however, that the type of battery used—whether lead-acid, nickel-cadmium, silver-zinc or silver-cadmium—is of great interest to engineers.

For the record, then—and for the information of those in the field who have called us to ask—the primary source of power for these new target simulators is a rechargeable *silver-zinc* battery manufactured by Yardney Electric Corporation.

Saul Padwo
Assistant to the Vice President
Yardney Electric Corp.
New York, N.Y.

## Optical Alignment

*To the Editor:*

Reference your article on the Twist Autocollimator optical alignment system for the *Minuteman* (M/R, Feb. 6, p. 33), as well as the letter of C. J. Weatherred (M/R, March 20, p. 48).

Your report on the system was superb, and Mr. Weatherred's letter was well justified. He was absolutely right in stating that Dr. J. G. Gievers is the Free World father of phased light systems for optical alignment. It is interesting to point out that such a system was available to the Army as early as 1957, but was ignored by some workers of the Von Braun team who didn't have the technical background to understand the system well enough to push its application for the *Redstone* and *Jupiter* missile systems. Fortunately, with excellent wisdom, most of these individuals are no longer with the team now employed by the Marshall Agency of NASA.

An additional point is worthy of mention—the Army, at that time, had little interest in even passive optical alignment devices for its *Redstone* and *Jupiter* systems—those states of the art which had been most effectively applied at Peenemünde when flatcar-stationed *V-2's* were fired with effectiveness, and when the German artillery hit targets with telling accuracy.

One sometimes wonders—maybe ex-Secretary of Defense Wilson *was* right in restricting the range of Army missiles.

Frank M. Cameron
Huntsville, Ala.

## No Slight Intended

*To the Editor:*

Enclosed you will find a letter from Mr. George Raymond of the Raymond Engineering Laboratory concerning an article ("New Breed of Recorders for Future Space Use") in M/R, Feb. 13. In the light of your recent editorial expressing concern about the deletion of contractors' names by certain Government agencies, I cannot help but feel that your treatment of the contributions of the NASA Research and Development activities is somewhat inconsistent.

At best, the issue is always a difficult one. I would hope that you could correct impressions left by your article on tape recorders in the referenced issue.

W. G. Stroud
Head, Meteorology Branch
Goddard Space Flight Center
NASA

*Mr. Raymond's letter to NASA said in part:*

"You have undoubtedly read the article about our tape recorders in M/R. Unfortunately there were some distortions in the article for which I wish to apologize on behalf of the company.

"We regret that the impression was left that we had designed and built the *Tiros II* satellite IR recorder. We acknowledge that our role here was minor, and that you people provided the technical leadership and skill which brought about the eventual success of the program. At the time the article was composed, the *Tiros II* satellite had not been launched, and our general association with the *Tiros II* recorder created the erroneous impression that the recorder was our own development and it would be in the satellite.

"The impressions left regarding the Mylar belts were also unfortunate. The only intent here was to state that we were using belts, and for what reasons, and not to claim their invention or development. We acknowledge, of course, that you and John were fully responsible for all of the basic work in this area. We are, in fact, grateful for the recent technical information published by you which has helped us in designing and fabricating belts for our own recorder developments. . . ."

*Background information for the article was provided to M/R by Raymond Engineering Laboratory, Inc., with the stipulation that the final version of the story be reviewed for technical accuracy by NASA. The story was reviewed at the Goddard Space Flight Center and approved Feb. 8, 1961, subject to one correction—the weight of the S-15 satellite was increased from 350 to 425 lbs. No other corrections were indicated.—Ed.*



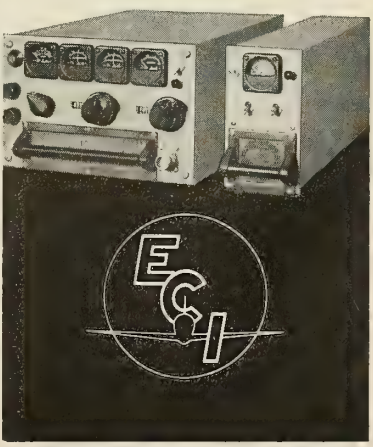


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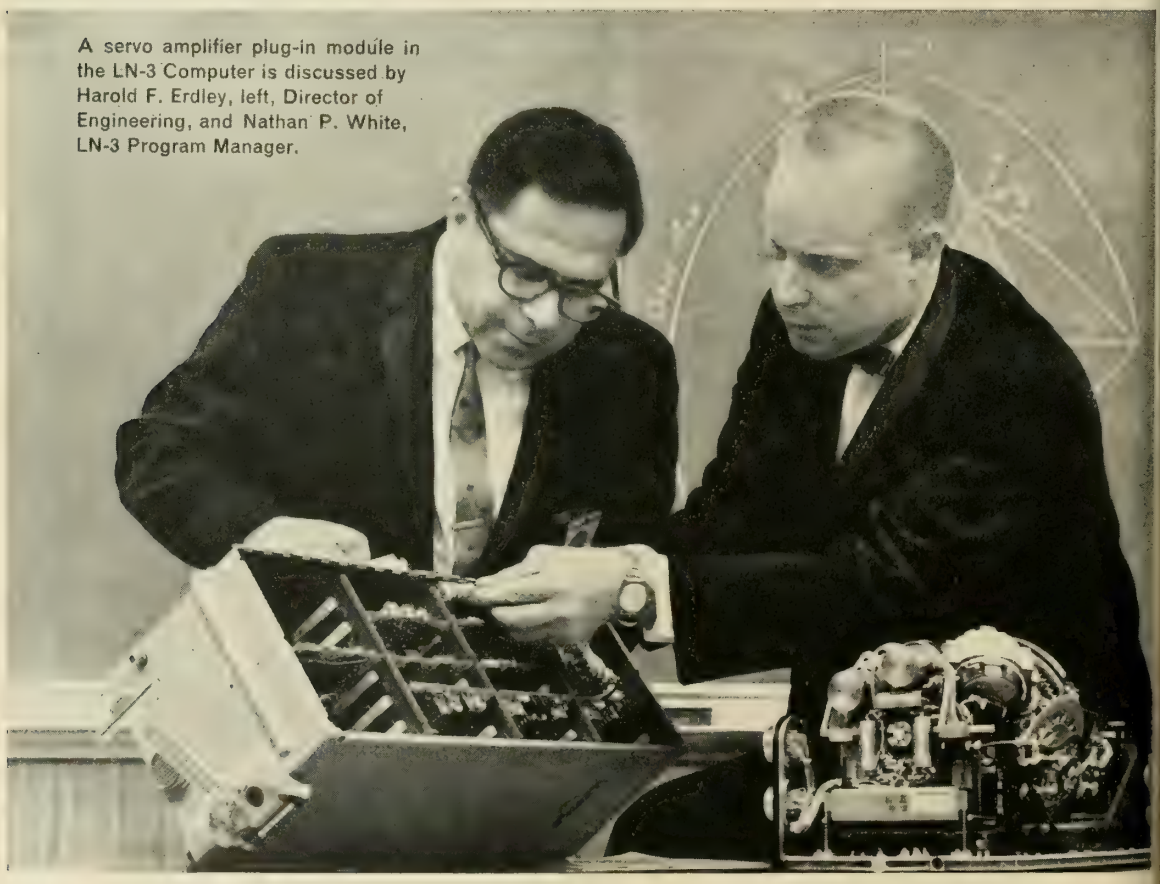
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# INERTIAL ENGINEERING INGENUITY

The Litton LN-3 Inertial Navigation System is a system in being. Production orders for this system to be used in the F-104 are, to the best of our knowledge, larger in number than those for any other inertial guidance system. The LN-3, consisting of a two-gyro, four-gimbal platform, computer, adapter, and controls, weighs less than 80 pounds installed. Even smaller systems, designed for orbital and sub-orbital guidance, are in development. These will weigh less than half as much as systems now in production.

Do you have experience applicable to the integration of developmental inertial guidance and computer sub-systems into functioning prototype systems? Can you evaluate performance in such systems with a view toward increasing system capabilities even further? If so, contact Mr. Donald A. Krause of our Research and Engineering Staff regarding your interests. You can share in generous employee benefits, including stock purchase and tuition-paid education plans. Relocation assistance is provided.

**LITTON SYSTEMS, INC.**
**GUIDANCE & CONTROL SYSTEMS DIVISION**
**Beverly Hills, California**



A servo amplifier plug-in module in the LN-3 Computer is discussed by Harold F. Erdley, left, Director of Engineering, and Nathan P. White, LN-3 Program Manager.

# The Countdown

## WASHINGTON

### The U.S. Space Program: More?

Many key congressional figures are now taking a second look at President Kennedy's FY '62 budget revisions in light of Russia's man-in-space feat. Their inescapable conclusion is that Kennedy made a clear decision NOT to try very hard to leapfrog the Soviets in space. Insiders are expecting a head-on struggle between Kennedy and congressional leaders who will demand an immediate step-up in space spending. Much depends, however, on public reaction. If there is no outcry, there may not be much of a fight.

### Missile Money Request

Defense authorization bill now before the House holds $3.976 billion for missiles. Air Force portion is $2.792 billion, Army $550 million and the balance for the Navy.

### Fight for Man-in-Air

Look for a possible switch in Air Force strategy before Congress. Big campaign now underway to restore funds to the B-70 may be dropped suddenly and the pressure redirected toward revival of the missile-carrying nuclear airplane. The Air Force is determined to get either one or the other.

### Satellite Killer

All Navy work in the "area" of antisatellite missile development is now being done under a program labelled "Early Spring." Naval astronautics experts contend that they could demonstrate workability of their proposed system by shooting down a U.S. satellite within 18 months, using a ship as a launch platform.

### More Advanced Terrier Development

COUNTDOWN hears there will be *Advanced Terrier* antiaircraft missiles aboard the aircraft carriers Constellation and Enterprise when they are commissioned this fall. Constellation, a Forrestal Class flattop, and the nuclear-powered Enterprise will each have two launchers for *Terriers.*

### Falcon Production Ending

Air Force plans to buy out *Falcon* GAR 3A, 4A and 11 air-to-air missiles in the FY '62 budget, ending one of longest missile production runs.

### Rubel Leaving?

Although he has been asked to stay on indefinitely, Dr. John H. Rubel is thinking of quitting as deputy director of DOD's Office of Defense Research and Engineering. The office is now headed by Dr. Harold Brown, a 33-year-old nuclear physicist who is expected to reverse some of the policies of his predecessor, Dr. Herbert York. Brown is concerned over using R&D to "better" long-range military strategy and dispense with "gimmicks."

## INDUSTRY

### Big Saturn S-II Stage Contract

NASA is getting ready to contract the largest rocket ever built by private industry—the 800,000-lb.-thrust *Saturn S-II* stage. It will measure 74 ft. in length, 21.5 ft. in diameter, and be powered by a cluster of four J-2 engines. Twenty firms are being invited to a pre-proposal conference April 18. List will be narrowed considerably before NASA invites bids. The contract probably will run to $100 million or more.

### Maxson is Bullpup Prime

Contrary to Navy-released statements, Maxson Electronics is the second-source prime contractor for *Bullpup,* responsible for all components except GFE motor and shipping container. Approximately 60% of the work will be subcontracted—none from Martin-Orlando *Bullpup* suppliers—and Maxson will manufacture and assemble at its Old Forge, Pa., plant. Maxson beat out 50 competitors for the $1-million contract, which is expected to bring large-quantity follow-ons—including sales to England.

### Navy Looking for ARM

Watch for a bidders conference to be called in the next month or two on a prospective Navy version of an antiradar missile (ARM). The bird could be built around the highly regarded passive radar guidance system developed for the defunct *Corvus* missile.

### Scouting the Pole

First *Scout* shots from the Pacific Missile Range's Pt. Arguello will be to determine if the "gap" in the Van Allen belt really exists over the South Pole. The probes will measure radiation at a point about 40,000 miles over the end of the earth.

### R&D Intelligence

Decoys being developed for the *Nike-Zeus* AICBM next year may look something like a child's "jacks" which will spring into shape when released from a reentry vehicle. . . . The Air Force's Aeronautical Systems Division is using a modified F-100F to simulate drag-lift conditions of advanced aerospace vehicles in an effort to eliminate need for long runways to accommodate *Dyna-Soar* and similar craft. . . . Convair is labeling every piece of hardware going into *Atlas* boosters for *Mercury*—a reminder to workers about quality control.

## INTERNATIONAL

### Ministerial Decision on Polaris

Any decision on whether NATO nations will buy *Polaris* missiles is being put off until the NATO foreign ministers' meeting in Oslo next month. The big question is whether the money would be better spent building up conventional forces. But hard-eyed military men see no chance of protecting Europe without nuclear weapons during the next few years.

### Overseas Pipeline

Word is being spread that if Germany balks at supporting the European satellite launching program, Britain and France will go it alone. . . . France has gone through with its plan to make 61-year-old Gen. Gaston Lavaud a "czar" over all deterrent weapons development. And his first move has been to put SEREB—the country's missile "brain trust"—under his direct control.

### Russian Promises

Soviet space scientists are promising to publish all the scientific information about their man-in-space flight —including possibly something on how it landed. What's more, they say that "in the future" foreign observers will even be invited to witness the return of Cosmic Ships.

SYSTEMS THAT HELP MEN MAKE DECISIONS AND EXERT CONTROL



Decision and control in today's military and governmental structure frequently must follow almost as soon as events occur. Yet the forces involved may span continents. And the information for control of these forces may be enormous in volume. ▪ To help leaders make decisions and exert control in response to events of the moment, we at System Development Corporation have helped create a new technology based on automated information processing assistance. ▪ SAGE is in operation as the first system of this new technology. Another — the SAC Control System — is in development. And we are working on two other extremely large systems in their initial stages. In contributing to these systems we have dealt mainly with their analysis and synthesis, training men in their use, instructing great computers on which they are based — and research into future generations of systems. ▪ We have developed an interdisciplinary approach to system development. The four fields are Operations Research, Engineering, Human Factors, Computer Programming. To staff our rapidly expanding programs in Santa Monica, California, Washington, D. C., and Paramus, N. J., we are seeking scientists and engineers in these fields. Please address Mr. R. L. Obrey, 2433 Colorado Avenue, in Santa Monica.

**SYSTEM DEVELOPMENT CORPORATION**

## hots of the Week:

Scientists are evaluating the first ata on the density of neutrons in the pper atmosphere, telemetered from *Blue Scout* April 12.

The shot was a forerunner of ests which may be able to detect igh-altitude nuclear tests. The Geo-hysics Research Directorate of the ir Force Cambridge Research Lab-ratories and The Martin Co.'s Re-earch Institute for Advanced Study RIAS) designed the 10-lb. package.

Two sets of boron trifluoride de-ectors were used to measure neutron ensity in relation to altitude from 70 1200 miles. The capsule was not ecovered because of stormy seas, but uch of the data was telemetered uring flight.

At Canaveral: A *Polaris* missile unched from a land-based pad tum-led into the ocean when the second-age motor apparently failed to ig-ite.

Earlier in the week, a NASA pace probe carried by a *Thor-Delta* ocket discovered the existence of a reat solar "wind" sweeping outward rom the sun into space at millions f miles per hour.

At Vandenberg: *Discoverer XIII* obstinately refused to eject its apsule in the right direction and sent further into space. The ejection ommand was given after a record .5-million-mile trip through space.

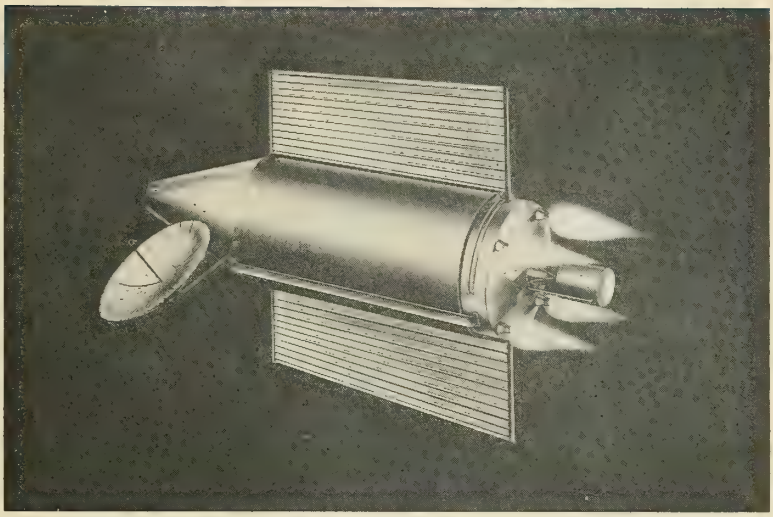
Somewhere in space: *Echo I* con-nued to stump the experts by going p instead of succumbing to atmos-heric drag as had been predicted. light pressure from sunlight acting n the satellite's great bulk and light eight has helped to keep it aloft, cientists now theorize.

## ouncil Bill Progress

The House Space Committee has pproved President Kennedy's bill to ake the National Space Council active and useful" and put Vice resident Lyndon Johnson at its ead.

The bill reduces the council's embership from eight to five—the ice president, secretaries of state, nd defense, the AEC chairman and he NASA administrator.

←—Circle No. 30 on Subscriber Service Card



### Spin-Away Spacecraft

*ARC JET-PROPELLED space vehicle concept by Avco incorporates four thrust units using hydrogen as propellant. Vehicle would be launched with chemical rocket boosters into low-altitude circular orbit. After separation, spacecraft would spiral away and could ultimately reach a 24-hour or lunar orbit.*

Dr. Edward C. Welsh, new executive secretary of the council, said a small but technically well-qualified council staff will be chosen soon.

## Transit Cost Set

The Navy's *Transit* satellite system, capable of providing a world-wide ship navigation system, will cost the government about $3 to $4 million yearly.

Capt. Robert F. Freitag, astronautics chief of BuWeps, also told the House Space Committee that the Navy is seeking to reduce the weight of the satellite from 260 lbs. to 100 lbs.—cutting launching costs to between $750,000 and $1 million. It also hopes to extend the lifetime of the *Transit's* electric gear from six months to from three to five years by using solar batteries.

## Sidewinder Tragedy

All training maneuvers with airborne missile systems have been discontinued until the Air Force finds out what triggered the *Sidewinder* missile that shot down a B-52 bomber April 7.

The incident, which occurred over Mt. Taylor, New Mexico, took the lives of two crewmen. Five parachuted to safety and were recovered.

The missile was unleashed from a F-100 fighter plane engaged in routine "war games" with the B-52. The nearly half-dozen separate safety checks needed to make the heat-seeking missile "safe" were said to have been made.

## A-G Standardizes Segments

Solid booster segments, 100 in. diameter and 11 ft. long, ultimately capable of 1 million pounds thrust with current propellants were presented to NASA and DOD last week by Aerojet-General. The segments can be joined in 97 seconds through a unique push-on coupling method. Sealing involves a rubber gasket and a simple steel rod.

The economical approach to big boosters faces only one more hurdle—thrust vector control—before quantity production is feasible. Aerojet says this can be solved in six or eight months from a variety of concepts including jetavator variations, swiveling nozzles and gas or liquid injection from points in the nozzle throat.

*first man in orbit . . .*

# Did Soviets Gain Giant Militar

- *Next Red Manned Space Shot expected shortly*
- *Landings on the moon appear to be the next major objective*
- *Will Kennedy be forced to alter U.S. program?*
- *Major blow dealt U.S. diplomacy in Asia and world trouble spots*




*ALMOST POLAR orbit carried the Soviet cosmonaut over South America and Africa Arrow indicates approximate launch area at 65°4' inclination.*

**by James Baar**

RUSSIA'S manned *Cosmic Ship IV* appears to have given Russia a giant lead in developing a winged military spacecraft—along with winning the world's laurels for beating the United States in the race to put a man in orbit.

At the same time, *Cosmic Ship IV's* historic flight:

—Brought renewed forecasts from top Soviet space scientists that Russia was pressing on toward early landings on the moon before the United States. They said another Soviet astronaut would be launched into space as soon as possible after examination of data from the first flight is completed. There also was talk of launching a Soviet space station.

—Forced into the open that the Kennedy Administration for the most part has adopted at least temporarily the "step by step" space policies of former President Eisenhower.

—Dealt a stunning propaganda blow to U.S. prestige throughout the world—particularly in Africa and Asia.

Key congressmen reacted cuttingly and unhappily to the latest Soviet space triumph. Several warned of dangerous military implications. But there was no immediate indication how hard they would fight to force through a greatly accelerated space program.

• **'A solid program'**—President Kennedy and NASA Administrator James Webb sought to ward off such a move with calming statements.

"As I said in my State of the Union message," Kennedy said, "the news will be worse before it is better and it will be sometime before we catch up."

Webb said the United States has "an orderly step-by-step program that will give us a basis for sound scientific achievement." Deputy Administrator Hugh Dryden echoed his words.

"The Soviet launching represents a technical accomplishment," he said. "We have of course been expecting the day for a very long time. We ourselves have formulated a program to meet the needs of the country, a solid program moving forward step-by-step."

Webb said that the United States might if it wanted have a Manhattan District-type program aimed at faster results. But he said that was up to the country and Congress.

"Our present program is more economic and sounder for scientific development," he added.

He made clear the Kennedy Administration had no immediate post-*Vostok* plans for increasing U.S. space efforts beyond the relatively modest increases already announced.

• **How word came**—Moscow Radio made the first announcement of the launching of *Vostok* at 2:05 A.M. EST.

"The world's first spaceship, *Vostok*, with a man on board has been launche on 12 April in the Soviet Union on round-the-earth orbit," it said.

"The first space navigator is Citize Pilot Major Yuri Alexseyevich Gagarir Bilaterial radio communications hav been established and are being main tained with Gagarin. He feels well."

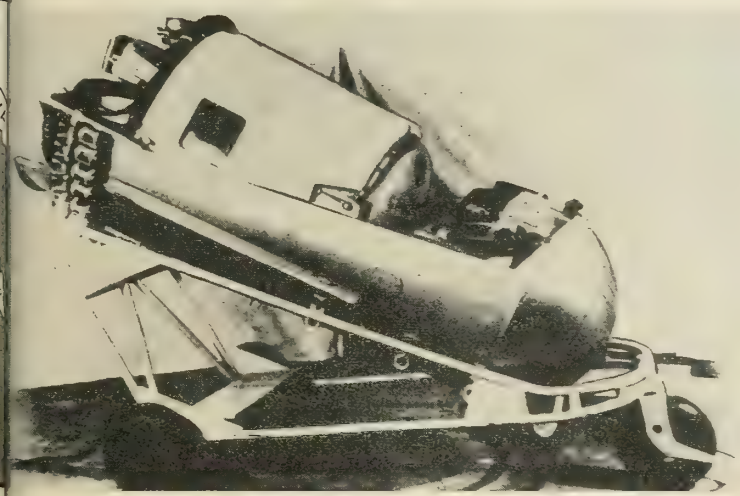
Then, according to Moscow Radic the 10,460-lb. *Cosmic Ship* complete one orbit around the earth and lande at an undisclosed point in the Sovie Union. Its perigee was reported to b 109.5 miles; its apogee, 187.75.

The orbit, which was in a 65 de gree, 4 minute inclination to the equa tor, took the *Vostok* and its pilot ove Africa and South America. The orbit period was 89.1 minutes. The complet flight from blast-off to landing too 108 minutes.

The Russians reported that th 27-year-old Gagarin landed safely o the "sacred soil of our homeland, th land of the Soviets." Then, while Rus sians poured into the streets of the major cities to celebrate, Gagarin wa examined by scientists who had watche him during the flight by TV—as the had watched the dogs who precede him. They said he showed no i effects from the strains of the trip including the more than an hour c weightlessness.

The White House disclosed that th U.S. worldwide radar net had tracke

# tep With Winged Spacecraft?



*IRST successful recovery from orbit by Soviets was Cosmic Ship II. It carried 2 dogs nd other biological specimens on launch last Aug. 19.*

ne *Vostok* throughout its flight. Presiential Press Secretary Pierre Salinger aid he was informed of the launching t 1:30 A.M. EST—35 minutes before was announced by Moscow Radio.

• **Winged implications**—The Rusians did not disclose the configuration f the *Vostok* nor the method by which re-entered the atmosphere and landed, robably in Kazakh east of the Aral ea. However, informed sources said ata considered reliable strongly indiated that the *Vostok* ejected a winged apsule that was landed as an aircraft.

Acadamecian Anatole Blaganravov, leading official in the Soviet space rogram and a Red Army lieutenant eneral, gave support to the report.

He said at a hastily summoned press conference at Florence, Italy, that although he had no specific information he assumed that the *Vostok* was recovered "by a combination of parachute and glider." He also revealed he had just been in contact with Moscow.

The implications were decidedly unpleasant.

Until now, the Soviet *Cosmic Ships* have been publicly regarded by both the Eisenhower and Kennedy Administrations as only king-size *Mercury* capsules. On this assumption, the *Vostok* only outclassed the 2500-pound U.S. *Mercury* capsule in weight and time.

But, as a winged spacecraft, the *Vostok* would be ahead of *Mercury* by a generation and in a class with the U.S. *Dyna-Soar* R&D program and the NASA *Apollo* study program.

Air Force officials and others have been warning for some time that the Soviets plan to develop a military space force and that the United States must develop offensive and defensive military space weapons. A winged *Vostok* points clearly in this direction.

Only 48 hours before Gagarin's flight top Air Force officials warned the Senate Armed Services Committee at a closed hearing that Russian space programs aimed at control of space could jeopardize the Free World's security.

The Eisenhower Administration repeatedly rejected this point of view. So far, the Kennedy Administration has indicated recognition of a military space threat but relatively few dollars have been forthcoming to do much about it.

The winged *Dyna-Soar* which is the country's most advanced hope of developing a true military spacecraft has been starved for funds for years and there were repeated delays on even getting it underway.

Through FY '61 a total of about $100 million has been committed to it. The final Eisenhower defense budget added another $70 million for FY '62. Kennedy in his budget revisions added another $30 million instead of the approximately $100 million sought by the Air Force.

*Apollo,* which is a civilian version of a winged spacecraft, has faired far worse. In fact, it hardly exists except in paper announcements and a few advanced studies.

The Eisenhower Administration put $29.5 million in its final space budget for a group of advanced space vehicle studies directly and indirectly applicable to *Apollo*. Kennedy added $125 million to the NASA budget mostly for speeding up work on propulsion programs, but he added nothing for *Apollo*.

As for other military space projects, Kennedy added money for warning and communications satellites but little new money was requested for advanced offensive and defensive space systems.

The alarm of congressional leaders over Gagarin's flight was best illustrated by Chairman John C. Stennis (D-Miss.) of the Senate Preparedness Subcommittee.

• **Weapon potential**—He said if a man can be orbited and recalled "it can be done with a weapon—with a whole lot of weapons simultaneously." He said consideration should be given to psychological impact and strategic implications of such a Soviet weapon system.

Chairman Richard B. Russell (D-Ga.) of the Senate Armed Services Committee said he thought the military implications of Gagarin's flight are not as significant as the implications for future space exploration. However, he also said the Soviets could be moving toward the development of a military

*(Continued on page 39)*

### 'We Are All Asleep'

***A reporter called Lt. Col. "Shorty" Powers, press officer for the U.S. astronauts at Langley AFB, Va., to inform him the Soviets had a man in space.***

***"It's 3 a.m. in the morning, you jerk," Powers shouted into the phone.***

***When the reporter suggested that despite the hour he would still like the views of the astronauts, Powers retorted:***

***"If you're wanting something from us, the answer is we are all asleep."***

# Soviet Aim Appears to be Man on Moon

RUSSIA'S SPACE program is now assuming a pattern which appears directed squarely at putting a man on the moon in the next few years.

Technical observers in the West note that the Soviets adhered tenaciously to a single concept in orbiting the first man in space. They are now broadening their program as it matures—in marked contrast to the U.S. program which has never developed any hard-and-fast goals.

There is evidence that some time before the Soviets opened the Space Age on Oct. 4, 1957, with *Sputnik I* they were planning to orbit a man. They obtained their first real knowledge that it would be possible with *Sputnik II*—just 30 days later. The second satellite containing the dog Laika apparently convinced the Russians that weightlessness, among other things, would not be a problem in orbiting a man for short periods.

Approximately 2.5 years later, on May 15, 1960, the Russians orbited a "space cabin" but failed to bring it back. This apparently did not represent a real obstacle because within three months a similar space cabin containing two dogs and other assorted creatures was successfully returned—and at a predetermined spot.

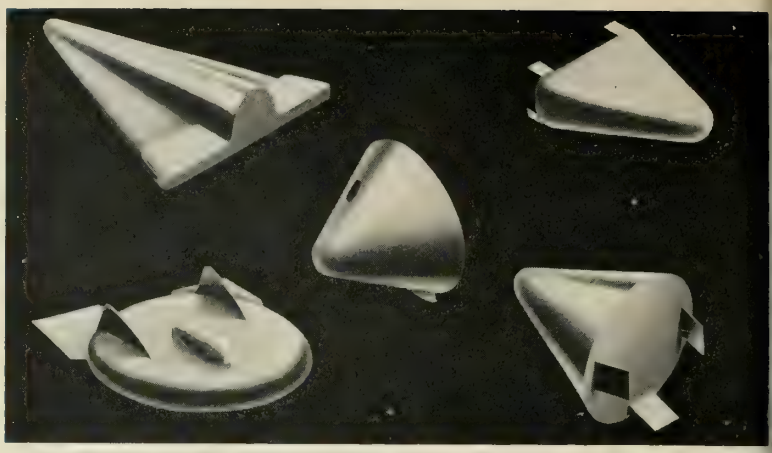
Once again, in December, 1960, a second space cabin failed to re-enter. The fourth space cabin carried Major Gagarin around the world and back to earth without incident.

• **Giant strides**—It is evident that *Sputnik II* answered quite a few questions. In the ensuing 30 months before the first launching of a space cabin in May, 1960, the Russians solved the major problems inherent in manned orbital flight, designed and built a vehicle, incorporated communications, guidance and the rest of the necessary paraphernalia and mated it to a booster.

There is only speculation concerning any possible failures during this period. It is not inconceivable that there might have been some, but it is obvious that the program did not appreciably falter.

The series of firings by the Russians in the Pacific were probably an integral part of the man-in-space effort.

*(Continued on page 39)*



*POSSIBLE CONFIGURATIONS of Apollo orbiting space laboratory under NASA study.*

# NASA May Cut Chimp Trip in Mercury Atlas Plans

THE UNITED STATES may be able to cut one step—an orbital chimpanzee flight—from Project *Mercury* development plans as a result of the successful orbital flight of Soviet cosmonaut Gagarin.

The Soviet success may also make it easier for the National Aeronautics and Space Administration to convince President Kennedy and Congress that it ought to have money to start hardware work this year on the *Apollo* three-man orbiting space laboratory, now targeted for flight in 1965 or 1966, thus advancing the funding by a full year.

Meanwhile, plans moved forward for the first manned suborbital flight, possibly during the last week of April. Dr. Hugh L. Dryden, NASA deputy administrator, said the earliest possible date is April 28.

High NASA officials maintain that it will be very difficult to speed the *Mercury Atlas* orbital program to any great degree. Three major intermediate milestones now are on the schedule before manned orbital flight. They are:

—Injection of the capsule into an orbital trajectory and immediate command of re-entry.

—Orbiting and re-entry of a capsule without passengers.

—Orbiting and re-entry of a capsule containing a chimpanzee.

Goal of the first test in the series—scheduled possibly in the next few weeks, is to prove out a fix in the *Atlas* forward section and to make the first *Mercury* re-entry experiment. The second is to accomplish re-entry from orbit. The final test is designed primarily to determine how a creature resembling a man withstands weightlessness for the time required for orbital flight.

However, since Gagarin has apparently demonstrated that weightlessness is no problem—at least during the period of one orbit—high NASA officials will consider dispensing with the chimpanzee-in-orbit test.

Compression of the plans would no mean that only two *Mercury Atla* flights would precede the orbital at tempt, even if both were successful High NASA officials emphasized th necessity of repeatability in achievin re-entry from orbit before risking th life of a man.

• **Appeal for Apollo**—It was under stood that NASA is preparing a nev appeal for funds for hardware work o the *Apollo* capsule. A high administra tion source said that President Kenned merely postponed the request fo *Apollo* funds, but did not rule out mak ing such a request before the end of th current Congressional session. Informe guesses were that about $50-$60 millio would be involved for FY 1962.

Space Administrator James E. Web told reporters he assumes the Presider will take under consideration the que tion of experiments in parallel, so as t buy time. The present *Apollo* progra is on a step-by-step basis, he sai Webb said parallel work would be mo expensive and there are some scientif objections to it.

Scheduling of the manned *Redsto* flight depends on the success of *Little Joe* test, probably this week, which the capsule escape system w be given its final checkout. It also d pends on successful completion of a drop tests of the capsule landing bag.

*ockheed proposal . . .*

# Syndicate for Communication System?

**by Jay Holmes**

AN INDUSTRY syndicate, organ-ed as a "common carriers' common arrier," is emerging as the most likely rganization of the ultimate operational ommunication satellite system.

High officials of the Kennedy Ad-inistration are looking with favor on e idea, first advanced by Lockheed ircraft Corp., under which all users the satellite facilities would jointly wn and operate the network.

Less than a month after the Ad-inistration took office, Lockheed ob-ined word from the Justice Depart-ent that the government would not roceed under the criminal provisions the antitrust laws against such a ombine—provided that organizers eep the government informed every ep of the way. The assurance did not le out the possibility that the gov-rnment might act under the civil pro-sions of the antitrust laws if it is not tisfied with the way the syndicate kes shape.

Lockheed advanced the idea on larch 1, in a lengthy brief filed with e Federal Communications Commis-on. The plan gained favor as an alter-ative to the plan originally advanced y former NASA Administrator T. eith Glennan, under which a single company would have paid the government the cost of launching experimental communication satellites.

Lockheed said its plan is based on the assumption that operation of satellites by private enterprise is commercially feasible beginning in the 1966-68 period—and technically feasible sooner.

• **Plans cancelled**—The question of monopoly is regarded by the new administration as the stickiest in the area of communication satellites. Officials of the Federal Communications Commission feel that it isn't practical to set up a number of competing satellite systems because of the immense cost involved. Thus they reason that some solution must be found to the problem posed by the antitrust laws.

As a result of the policy questions involved, Space Administrator James E. Webb cancelled plans in the Eisenhower administration budget for the government to receive $10 million from private industry as payment for launching an experimental satellite during Fiscal Year 1962. Webb told the House Space Committee last week he still assumes that industry will take part in developing the operational system. He added that NASA plans to go ahead with its own research and development plans, but that the government will pay the whole bill in the coming year.

Under the previous administration, the American Telephone and Telegraph Co. had proposed to enter negotiations with the government on plans to have the government launch its satellite within the next year or so. On Jan. 19, the last full day of the Eisenhower Administration, the FCC granted AT&T permission to use the 6325-6425 mc and the 4100-4200 mc bands for its experiments.

Some industry quarters maintained that the AT&T plan might lead to a space communications monopoly. The company denied this, saying that the system would be operated under government regulation and that service would be available to all comers, just as in the operation of present commercial communication systems.

The Lockheed plan calls for the private group—of which Lockheed would be the operating agent—to launch the satellites on behalf of the common carriers. It is in competition with proposals in some quarters—still rather nebulous as to detail—under which the government would be the launching agent.

There is also some question about whether it would not set Lockheed in a monopolistic situation on component manufacture. The argument is being

## *NASA's Communication Satellite R&D Schedule*

| PROJECT | SPACECRAFT | LAUNCH VEHICLE | TRAJECTORY | LAUNCH PLANS |
|---|---|---|---|---|
| S-3 | Radiation experiment package weighing 85 lbs. | Delta | Elliptical orbit—a few hundred to 30-40,000 miles | Third quarter 1961 |
| ECHO II | 135-ft. rigidized sphere; weight 500 lbs. plus 100-lb. container | Thor | Suborbital—to 7-800 mile altitude, 600 miles downrange | Two shots: last quarter 1961 and first quarter 1962 |
| ECHO II | Same | Thor-Agena B | 700-mile orbit | Second quarter 1962 |
| RELAY | Active repeater, weight 85 lbs. | Delta | 1000-3000-mile orbit | Two shots in 1962 |
| ARENTS | NASA-DOD payload including "piggyback" S-3 | Centaur | 22,300-mile circular equatorial (24-hour) orbit | Three shots planned in 1962 and 1963 |
| RELAY-ADVANCED | Two Relays in one payload | Atlas-Agena B | 5000-6000-mile orbit | Not set |
| REBOUND | Three Echo II's in one payload | Atlas-Agena B | Circular orbit 1500-2500 miles | Mid-1963; backup available |
| REBOUND-ADVANCED | Six Echo II's in one payload | Centaur | Circular orbit 1500-2500 miles | 1964; backup available |

made that joint ownership solves the problem of communications monopoly, but not in the area of launching vehicle manufacture. However, there seems to be no serious question that a single company or agency would actually handle launchings, whether for the government or for a commercial syndicate.

• **Chairman intent**—Newton H. Minow, the new chairman of the FCC, told M/R, "I regard the problem of communication satellites as one of the most central and urgent we have to deal with in the 1960's."

The 35-year-old Minow, a former law partner of Adlai E. Stevenson, pointed out that the Communications Act under which FCC operates requires the commission to encourage private enterprise to advance the state of communications technology in every way possible. It follows, he said, that the commission has a duty to support efforts by industry to enter the satellite field as soon as practical.

The commission has asked industry to file briefs by May 1 discussing the antitrust question.

T. A. M. Craven, a holdover FCC commissioner from the Eisenhower Administration—who also served a seven-year term under Franklin D. Roosevelt, said he disagrees with Webb's decision on industry participation. If he had his way, Craven declared, a private company or group of companies would be given a go-ahead within the next few months. However, Craven said he expects the Webb decision will be merely a delay in the ultimate decision to go ahead with industry participation.

Some stir has been caused by the problem of overlapping military and civilian jurisdiction in the area of communication satellites. This will be one of the issues given to the National Aeronautics and Space Council, to be headed by Vice President Johnson.

But the question of division of space between the private and government sectors must be settled by negotiation. The same is the case between military and civilian agencies within the government. The FCC chairman declared that someone should be put in charge.

Leonard Jaffe, NASA chief of communication satellites, emphasized in an interview that a great deal of research and development will be necessary before a system can become operational. However, he said the question of timing is for the ultimate user to decide. NASA's job is to advance the state of technology, leaving to others the question of when the technology is commercially feasible.

Jaffe outlined a NASA program of research beginning with test flights of a rigidized 135-ft. balloon satellite late this year and continuing through multiple launchings of six at a time by 1964. One of the most important phases of the program, he said, is the NASA satellites for measuring radiation in space—the next of which will be the *S-3*, launched in the third quarter of this year.

# Fuel Cell Uses Bacteria to Produce Power

A BIOCHEMICAL fuel cell developed by government scientists is tabbed by many experts as one of the most significant advances yet made in energy conversion.

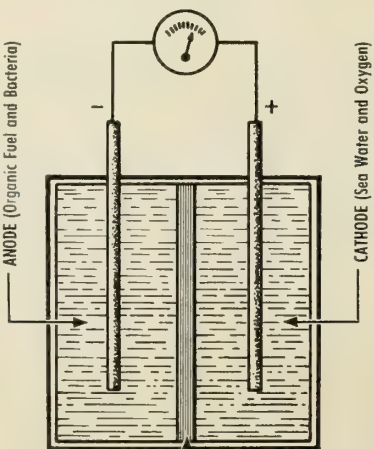
The cell, developed by Dr. Frederick D. Sisler, Department of the Interior Geological Survey biochemist, produces electricity directly from the decomposition of organic matter.

Dr. Anthony Moos, vice president of Leesona Corp. and an authority on energy conversion, said the development is "extremely significant." This is true, Dr. Moos noted, not only because the cell uses cheap and available fuels and oxidant, but also because its production of electrical power marks the first use of biochemistry for providing anything other than man's basic needs of food, shelter and clothing. Hence, the door is opened to a new utilization of biological systems for the service of man.

Although not tied to any particular application, the biochemical fuel cell could be important in space as well as on earth.

• **Clue from deep**—Dr. Sisler based his work on the observation that ocean-bottom sediments and their overlying sea water act as a gigantic fuel cell. Under natural conditions, the energy produced by such a process is dissipated as heat. (The heat generated in the middle of a compost pile is a similar example.)

The primary feature of the new cell is its use of abundant and inexpensive materials as fuel and oxidant. The prototype unit is composed of two sections containing inert electrodes—an anode section and a cathode section—separated by an ion-diffusion bridge. The anode section contains a mixture of sea water and organic matter as fuel, and bacterial cells (or enzymes) as a catalyst. The cathode section contains sea water and oxygen. The energy released comes from bacteria "burning" the organic matter, but the energy is released as electricity rather than as heat.




*LABORATORY PROTOTYPE of biochemical fuel cell produces electrical energy directly from decomposition of organic material created through photosynthesis and biological processes in sea water.*

Sisler says an inexpensive supply of both oxygen and organic matter for fuel can be obtained by placing living algae in the cathode section. Such a cell, containing inorganic salts, bacterial cells and algae, could conceivably produce electricity indefinitely from solar energy alone. In addition, a great variety of otherwise practically useless organic materials could be used as fuel in place of solar energy and converted directly to electricity.

Survey scientists estimate the efficiency of the biochemical fuel cell to be equal to or higher than that of the most advanced types of conventional powerplants (35-40%). They say that much-higher-efficiency biochemical cells can probably be developed which could result in a revolutionary source of power for specialized and industrial use. According to Sisler, such use would probably be limited to intermediate load and voltage applications.

The research was funded by Geological Survey and, until now, has received no military support. The Army Research Office—which has DOD cognizance of fuel cell programs—is interested in the potential of the device and will probably back further development. The Signal Corps has also expressed interest in pursuing the work. It is understood, although not confirmed, that the Navy is supporting an extensive program in biochemical energy conversion.

*New Money Makers for Industry:*

# KIN TEL CLOSED CIRCUIT TV SYSTEMS

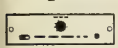
*what they are, and what they can can do for you...*

## What is a KIN TEL Closed Circuit TV system?

The basic KIN TEL closed circuit TV system consists of a camera, camera control unit, and monitor, each connected by cable. The camera can be located at great distance from the monitor, and any number of monitors may be used to display the same picture.



Cameras are small enough to hold in your hand; rugged enough to operate in virtually any environment; versatile enough to cover (via remote control) almost any area; and sensitive enough to provide excellent pictures of subjects illuminated by a single candle.



The camera control provides automatic operation. The system is continuously self-adjusting for wide variations in light levels (several thousand to one), and features automatic high definition of bright objects. The only control you have to touch is the on-off switch.

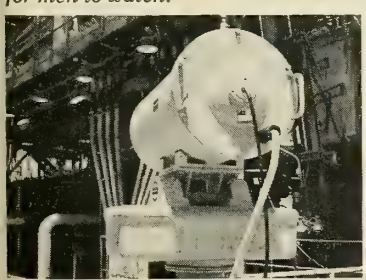


The monitor displays a crisp, clear picture...full 650-line resolution, twice that of the best home TV reception.

## How are such systems used?

Today, KIN TEL TV systems are performing a number of jobs for *hundreds* of firms, safely, inexpensively, tirelessly.

*They are being used to watch operations or events that are tedious, difficult, dangerous, or even impossible for men to watch.*



**For example:** Convair (above), Douglas Lockheed and Northrop watch rocket tests with KIN TEL systems. U.S. Steel uses one to see inside open hearth furnaces. Westinghouse watches nuclear power reactor tests with one.

*They are being used for surveillance.*

**For example:** The San Francisco Naval Shipyard uses one to guard against pilferage.

*They are being used for traffic control.*

**For example:** The Alameda Naval Air Station uses a KIN TEL TV system to observe aircraft landings on the portion of the runway that is not visible from the control tower.

*They are being used to transmit visual information quickly and accurately; for remote observation of charts, meters, graphs, schedules, blueprints, photographs, images from microscopes, fingerprints, signatures...the list is almost endless.*

**For example:** E. F. Hutton uses a KIN TEL system to transmit stock market quotations to the offices of the firm's executives. The Los Angeles Department of Water and Power uses one for remote viewing of water-level meters. The University of California teaches physics with one.

*They are being used for monitoring any operation that normally requires standby personnel.*



**For example:** American Potash and Chemical (above) monitors conveyor line and warehousing operations with a KIN TEL TV system.

## Why do these firms choose a KIN TEL system?

For a variety of reasons.

**First,** *reliability.* KIN TEL TV is designed for continuous duty operation in severe environments. Day in and day out, it keeps working. It's the first choice for ICBM and other missile programs that really depend on TV, that can't chance failure, that can't afford to compromise with reliability.

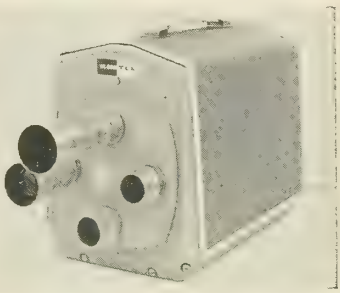
**Second,** *picture quality.* KIN TEL TV presents clear, sharp pictures. Full 650-line resolution provides maximum data...essential for *quantitative* observation of complex operations or transmission of printed material.

**Third,** *automatic operation.* KIN TEL TV is the only closed circuit system that provides entirely automatic, through-the-lens compensation for light-level changes of several thousand to one.

**Fourth,** the KIN TEL closed circuit TV system is extremely *sensitive.* The light required to read this page is enough for sharp clear pictures, and usable pictures can be provided with less than one-foot candle illumination.

**Fifth,** KIN TEL TV systems are *easy to install* and *simple to operate.* With no changes in lens iris to make, with no difficult, interacting electrical adjustments required, the only thing the operator has to know is the location of the on-off switch.

**Sixth,** a *complete* line of shelf-item system components and a variety of cameras and monitors make virtually any application feasible...permit observation of nearly every kind of operation, under all kinds of conditions.



For example, with system components, you can remotely position the camera, remotely select one of several lenses, remotely "zoom" in or out for closeup or wide-angle viewing, operate the camera in extremes of temperature or in explosive or dusty atmospheres, view microscope images. Whatever your viewing problem, KIN TEL probably has a *stock* solution.

**Seventh,** you don't have to waste your time and money on application engineering. At no obligation to you, KIN TEL's nationwide factory-trained field engineers – thoroughly experienced in optics, environmental requirements, lighting, cabling, human engineering factors, and other installation considerations–can determine whether or not closed circuit TV can be put to profitable use in your intended application.

## What can a KIN TEL system do for your business?

It can do what it is doing right now for hundreds of other firms. It can save you time and money...increase efficiency...better your service to clients and customers. To find out how, write direct for catalog 6-205 and the name of your nearest KIN TEL engineering representative.

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# Skybolt launching pad.

Any piece of sky can be the launching pad for Skybolt air launched ballistic missile. This radically new deterrent weapon is designed to have global mobility. It will be carried, and launched in flight, by the USAF B-52, or RAF Vulcan. When it becomes operational, four Skybolts may be launched from the same B-52 to strike multiple targets up to 1000 miles away. The very existence of such a flexible retaliatory force will be a formidable deterrent.

The stellar-monitored inertial guidance system for the USAF-Douglas Skybolt is being developed and built by Nortronics.

**NORTRONICS**
A DIVISION OF
**NORTHROP**

# Technical Countdown

## ELECTRONICS

### Electronic Circuits Survive High Radiation Levels

Recent nuclear radiation tests show that most electronic circuits can be expected to operate satisfactorily under high radiation levels in nuclear-powered aerospace vehicles. Twenty out of 24 representative circuits successfully operated after a 100-hr. exposure to $5 \times 10^{16}$ neutrons/cm$^2$. The only transistor circuit in the test failed before the reactor was brought up to full power. All other circuits contained glass or ceramic tubes. Chance Vought conducted the experiments for the Air Force.

### MM Computer Poops Out, Finally

Autonetics finally ran a *Minuteman* guidance computer to death. Started in mid-1959, the solid-state digital system has been operated for over 12,000 hours with no major breakdowns, the NAA division said. None of the super-reliable electronics components which some day will be used in the system were employed in this life-test device.

### Minified Guidance Passes Tests

Litton Systems Inc. has just successfully sled-tested its new inertial guidance package. The 30-lb. P-200 stable platform used is half the size and weight of comparable units in today's missiles. Litton said the 80-lb. inertial system has passed all environmental tests, as well as centrifuge and sled tests—both with peak sustained accelerations of over 10 g.

### Solar Cell Measurements Up to Manufacturers

Bureau of Standards says that complaints of lack of standards to measure solar cells efficiencies are unfounded. They point out that the standards are available, and the problem is that manufacturers must agree on measurement procedures.

### Russians Also Have Ions in the Fire

A conference on theoretical, experimental and applied aspects of magnetohydrodynamics held in Riga drew over 100 papers, the Russians report. Plasma physics came in for special attention. The Institute of Physics of the Latvian Academy of Sciences—described as a major center for MHD studies—presented most of the papers on applied aspects.

## SUPPORT EQUIPMENT

### AF Study Aimed at Better Checkout Systems

A 14-month study by Battelle Memorial Institute is expected to lead to better automatic weapon system checkout equipment. Results of the Air Force study will be available to designers to help them better understand the basic problems associated with the checkout of missiles at the operational level.

### Long-Sought Librarian Found

A microfilm storage-data retrieval-printer system has been developed which can locate and print information at a rate of 6400 pages/minute. Called Filesearch, it was built by FMA, Inc., in El Segundo, Calif. A single unit accommodates 1.6 million pages of data and employs electro-optical techniques for retrieval. Cost: $100,000 plus.

### Converter Ties Computer to Checkout System

A digital interface converter which ties together a general-purpose digital computer with standard test stimulus and measurement blocks to form an integrated checkout system has been developed by RCA. The converter allows use of existing high-speed computers, on a time-shared basis, to provide arithmetic and programing functions for testing.

### Stretch Computer Completes Tests

Pre-shipment reliability tests on the IBM Stretch computer have been completed, and Los Alamos Scientific Laboratory expects to have the "super computer" installed and operating by early summer. The computer exceeded its reliability specifications by a considerable margin. Stretch, whose development began in 1955, will handle "floating point" calculations 20 to 30 times faster than the IBM 704.

### Soviets Develop Helium Machinery

Two new machines for producing liquid helium are entering the Soviet research effort. One machine, now in production, produces 1.45 gallons of liquid helium an hour. Liquid nitrogen is used to cool the apparatus during operation. Another machine, still in the experimental stage, produces almost four gallons an hour without need for nitrogen cooling. The Russians say the efficiency of both machines is greatly increased with use of plastic pistons and valves.

## ASTRONAUTICS

### Oxygen-Maker Developed for Space

A working prototype of a system to convert an astronauts' breath into reusable oxygen has been built for the Air Force. The system converts $CO_2$ into carbon and water. It is designed to operate continuously on space voyages lasting as long as three years.

### Fifty Miles Probable Ceiling on X-15

The *X-15* has enough propulsive power to carry it well above 50 miles, reports NASA Deputy Administrator Hugh L. Dryden. The question is whether it can be brought down safely from such an altitude. The skin, nose, and wing leading edges are designed for a maximum re-entry temperature of 1200°F. The rocket plane will be programed for gradual increases in altitude until the temperature reaches 1200°. It's unlikely such a flight will carry it above 50 miles. So far, temperatures of 500-600°F have been recorded on flights up to 32 miles.

## ADVANCED MATERIALS

### Corrugated-Core Sandwich Panels Developed

A roll-welding process which uses hot rolling for pressure-welding peaks of corrugated metal cores, to cover sheets without jigging, has been developed by metallurgists at Battelle Memorial Institute. The panels can be extensively formed after assembly; then the V-shaped inserts are leached out. The cost-cutting method has been successfully applied to 2014 A1 alloy, B-120 VCA titanium, unalloyed A-55 titanium, steel, molybdenum and Inconel.

### Cryogenic Radiation Investigated

The effects of nuclear radiation on metal alloys at −423°F are being studied at Convair-Ft. Worth. Titanium, stainless steel and aluminum alloys are involved in the program. The results will be applied to nuclear-powered rocket engines using liquid hydrogen as a working fluid.

←——Circle No. 6 on Subscriber Service Card

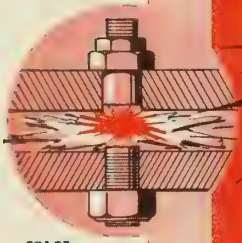


THRUST TERMINATION



Complete Missile & Space Vehicle Ordnance Systems

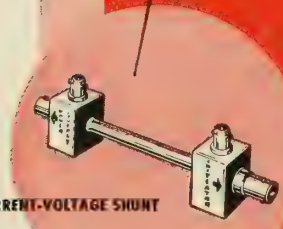
XB



STAGE SEPARATION BOLT



MISSILE DESTRUCT



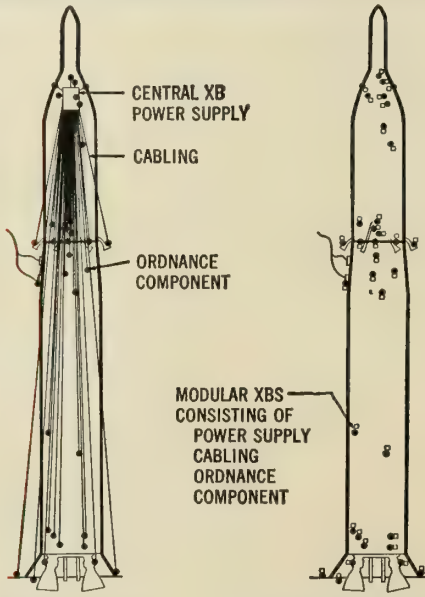
XB CURRENT-VOLTAGE SHUNT

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*by McCormick Selph Associates offer:*

1. Greater System Reliability
2. Simplified Cabling Problems
3. Greater Design Flexibility

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COMPLEX CENTRAL XB POWER SUPPLY SYSTEM

XBS MODULAR SYSTEM CONCEPT BY McCORMICK SELPH ASSOCIATES

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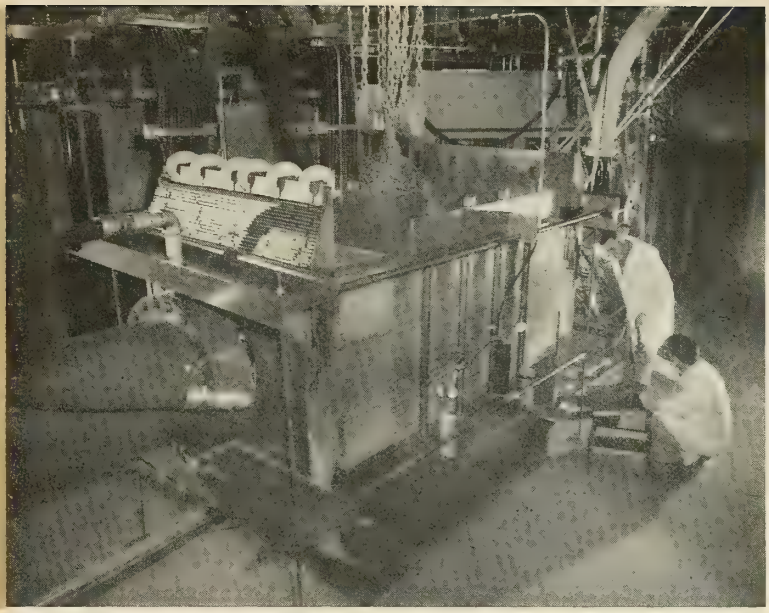
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*ELECTROMAGNET of Mark II experimental MHD generator is made of 25-ton pole pieces and 22 tons of copper plates connected to form coil. Magnetic field is formed across channel running through center of magnet. Power is delivered to loads through two sets of cables (upper left). Pipe (lower left) carries off exhaust gases.*

# MHD Power Experiments Top Results Expected

**by Hal Gettings**

RESEARCH in magnetohydrodynamics (MHD) for commercial power generation is paying off a lot better than expected.

The first year of research with an experimental generator has produced power levels and efficiencies much higher than was thought possible a year ago.

The successful production of 205 kilowatts of power is 20 times the level produced when the project was first announced, in late 1959. Further development of the new generator is expected to bring the output level up to 500 kw for short periods. Earlier estimates that efficiencies of powerplants could be improved by 25% have been upped to 40%.

Avco Everett Research Laboratory is conducting the experimental work, in association with a group of electric utility companies. The initial successes have caused the group—called American Electric Power Service Corp. (AEP)—to triple its current research budget to $1.2 million. Ten companies joined with Avco when the project began; two more have been added recently.

• **Result of space research**—Techniques of MHD power generation are a direct fallout from research in missile/space projects. Avco, a leading R&D defense contractor in re-entry physics under the leadership of Dr. Arthur Kantrowitz, has studied MHD for power and space propulsion for the past four years. Knowledge gained in this work and associated areas of plasma physics is now being turned toward commercial applications.

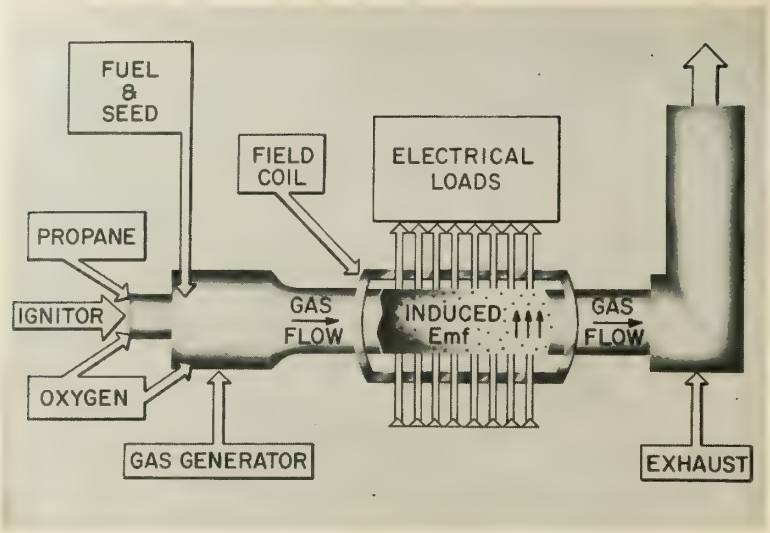
The research group's enthusiasm for the possibilities of MHD is practically boundless. Philip Sporn, president of AEP, says that MHD "is probably the most exciting area of development in power generation today" and the program "has yielded results more favorable than we could have reasonably expected at the end of 1959."

• **Materials problem**—One big reason for the enthusiasm is the fact that the past year's studies solved one of the major problems in MHD: materials vs. temperatures.

Temperatures in excess of 4000°F are required before combustion gases can become conductors of electricity. Hence it was necessary in the original power cycle to preheat the combustion air above 3000°F for efficient operation of the MHD plant. There are still no materials capable of withstanding such temperatures.

To solve the problem, Avco and AEP studied power cycles in which the combustion air is enriched with oxygen before being fed to the preheater and combustion chamber. The use of oxygen reduces preheat requirements to the point where a conventional material, such as stainless steel, can be used. The new cycle yields performance and economics comparable to those of the original air cycle. Use of an "oxygen cycle" means that commercially available regenerators (preheaters) can be used in the MHD system; a new regenerator design is not necessary. Therefore, only the generator itself requires further development.

• **Eliminates two moving parts**—The basic principle of the MHD generator is the same as that of a con-




*FUEL AND OXYGEN are burned in MHD power generator to produce high-temperature (5000°F) electrically conducting gas. Ionization of gas is increased by seeding with a potassium salt. The ionized gas flows down channel and through magnetic field, creating electric voltage. Power is tapped off on electrodes attached to inside of channel.*

ventional generator: an electrical conductor moving through a magnetic field generates a voltage. The conventional generator uses a solid conductor (armature) driven by a turbine, while the MHD device uses a stream of high-temperature ionized gas (plasma) moving through a magnetic field. Thus, the plasma replaces both the armature and the turbine.

When highly stressed, hot parts are eliminated and a cooled channel is used, very-high-temperature gases can be utilized in the generator. High peak temperature in a thermodynamic cycle is synonomous with high cycle efficiency.

In the experimental Mark II generator, the hot plasma is provided by a combustion chamber, somewhat similar to a rocket thrust chamber. The combustion chamber burns kerosene or alcohol and oxygen "seeded" with powdered potassium salts to make the plasma an electrical conductor. The combustion chamber runs at about two atmospheres pressure, and burns about four pounds of mixture per second. The plasma enters the generator channel at a temperature of about 5000°F.

The Mark II is designed for runs of up to one minute, which is more than adequate for studies of fluid mechanics. Long-duration tests of generator components will be conducted on a smaller scale. The information obtained from building and operating this generator will help to determine the answers to many questions about practical MHD power generation: engineering problems connected with large-scale generators; actual vs. theoretical performance; effects of high temperatures on materials.

• **Economics considered**—The economic feasibility of the MHD powerplant has also been studied during the year. AEP says that developments have reinforced earlier conclusions that the MHD system can give greater efficiencies at capital costs competitive with conventional powerplants. They contend that the first MHD powerplants could be as much as 40% more efficient than existing electric powerplants at the outset—and still have a long future of refinement and development ahead.

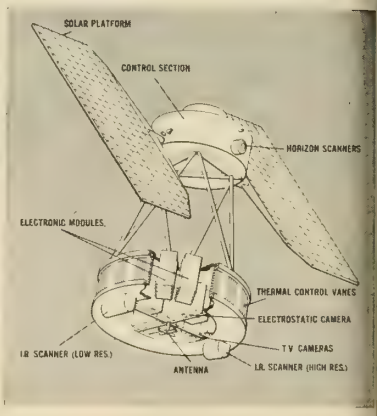
• **Continuing research**—One aim of AEP's continuing research and experimentation program is to determine the most efficient and practical generator system. It appears now that the first working MHD powerplants will be fossil-fueled open-cycle systems, but researchers are hopeful that continued development of nuclear power sources could mean the eventual use of closed-cycle nuclear-fueled MHD systems.

Many other aspects of the MHD generator system are under study, including various methods for converting the direct-current output of the generator to alternating current. At present, simple inverters appear to be the most feasible means of creating a-c, but some consideration is being given to ideas for making the generator produce a-c directly.

In addition, the basic nature of high-temperature plasmas and their interactions with magnetic fields is under continuous study which, it is hoped, will lead to significant improvements in existing concepts and devices. ⁂




## PROJECT NIMBUS




Nimbus is the second step in NASA's research and development program to study weather technology. Differing from its predecessor, Tiros, Nimbus will view the Earth at all times.

**Orbit**—Weighing approximately 650 lbs., Nimbus will circle the earth every 108 minutes in a 600 mile-high polar orbit.

**Equipment**—As many as 6 TV cameras, plus infrared measuring devices, tape recorders, telemetry and command instruments will be contained in the satellite.

**Data Acquisition**—Cloud pictures and other information will be played back on command to U.S. meteorologists at Fairbanks, Alaska. Foreign scientists, also, will be invited to participate in the program.

**Control and Stabilization**—A specially built system will keep TV cameras always oriented toward the earth and permit cameras to view particular sectors of the global cloud pattern.

General Electric's Missile and Space Vehicle Department will provide systems integration for Nimbus, and will develop the control and stabilization system. MSVD is a department of the G.E. Defense Electronics Division. 160-03

GENERAL ELECTRIC

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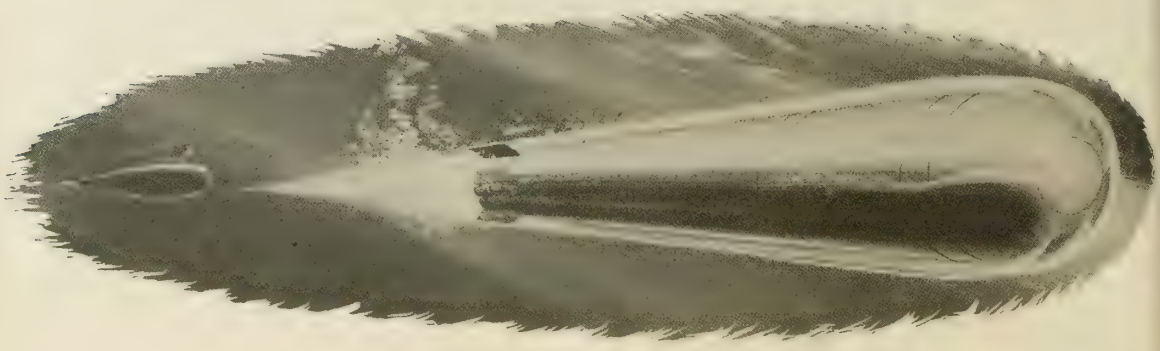
MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

**NIMBUS** will be America's next-generation weather satellite in space. Continually viewing the globe with TV cameras and other sensors, Nimbus will help man forecast the weather and learn more about its causes. General Electric's Missile and Space Vehicle Department is constructing the space craft and providing systems integration for the system designed by the National Aeronautics and Space Administration.

GENERAL ELECTRIC



# Air Wrapping May Speed Torpedoes



**by William Beller**

SPEED of underwater missiles may be more than doubled through experiments being conducted on vapor boundary layers.

Ever since nuclear submarines first showed their high-speed abilities, the Navy has looked for some way to increase the speed of torpedoes without sacrificing weight and volume for more powerplant. The service fears that future enemy nuclear submarines will be able to outmaneuver—and certainly outspeed—present-day torpedoes.

• **An air wrapping**—One answer may come from a proposal that an underwater missile be wrapped in a sheath of bubbles which would act as a lubricating sheet and reduce the water friction drag almost to zero. This leaves only pressure drag—a small part of the total hydrodynamic drag—for the powerplant to overcome.

"The trick is to produce a stable vapor layer between the solid surface and the liquid," say Walter S. Bradfield, Robert O. Barkdoll and John T. Byrne, the Convair scientists who have been testing out the scheme.

The vapor layers studied were produced in one of three ways: by film boiling, by sublimination of a solid surface, and by a heated chemically reacting surface. The results show that there is a thermodynamic region within which a stable vapor layer may be expected, and where the theoretically reduced total drag actually occurs.

So far, the vapor layer has been kept stable up to only 20 fps, where the friction drag is just about gone. This speed is a long way from that wanted. No theoretical limit has been found, however, and the experiments are being continued with optimism.

The instability that develops comes with the transition from laminar flow to turbulent flow in the liquid boundary layer immediately outside the vapor layer.

To put it another way: When a body moves through a liquid, a certain amount of the liquid is dragged along. This is the liquid boundary layer. When the transition from laminar to turbulent flow occurs in this liquid layer, vortexes develop in the interface between the vapor and the liquid. These vortexes start a mixing process, which develops a froth flow immediately adjacent to the solid surface.

The resulting vapor-liquid mixture increases the friction drag over the laminar flow condition. However, Bradfield says that even this drag would probably be less than that caused by the liquid alone.

• **For spurts only**—It appears that a vapor-producing skin is valuable only for short spurts, now measured in seconds, because the energy that produces the vapor is necessarily potential energy. Producing a vapor continuously does not seem efficient, because the energy might better be used powering the propulsion unit itself. Still, like the rocket assist given to aircraft, the extra energy may be imparted during an especially critical period in a torpedo's trajectory.

The experiment included drag measurements with and without model heating. Water temperatures were varied between 180°F and 193°F, within the subcooling range that gave the most stable vapor layers.

There were other tests, including drag measurements on graphite models with nucleate boiling (bubbling), on unheated teflon (non-wetting), and on subliming dry-ice hemisphere-topped cylinders. It was found that nucleate boiling caused a large drag increase over that measured with the unheated graphite model.

It was also found that the unheated teflon (non-wetting) produced no appreciable friction-drag reduction when compared with a wetting surface. In addition, sublimation of dry ice produced large, unruly, gas-filled cavities—in contrast to subcooled film boiling—and large drags under prolonged forced convection.

The experiments indicate that the bounds on the stable vapor layer are set by the subcooling temperature, surface condition of the body, its velocity, and by the onset of hydrodynamic cavitation.

Further experiments are needed in vapor-layer generation and control, possibly by combining suitable features of film boiling with chemically reacting and subliming surfaces.

The research section at Convair is continuing a study to see how far performance limits can be extended by using a subliming surface alone. Later, they will investigate more intensively a chemically reacting surface such as sodium or lithium or pure aluminum.

For practical reasons the heated-surface concept is being discarded. Not only would a "hot" missile be difficult to handle but also its thin skin would have low heat capacity—and, therefore, poor performance.

Further extrapolations of these studies might lead to submarines being controlled by selectively heated or reacting surfaces and torpedoes traveling at sonic speeds. But for the present, the job is to establish the bounds of vapor stability. ⌘

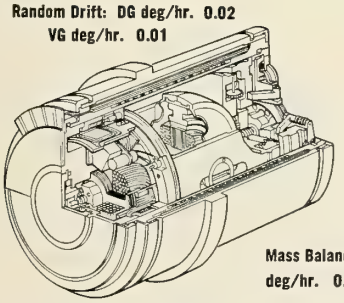
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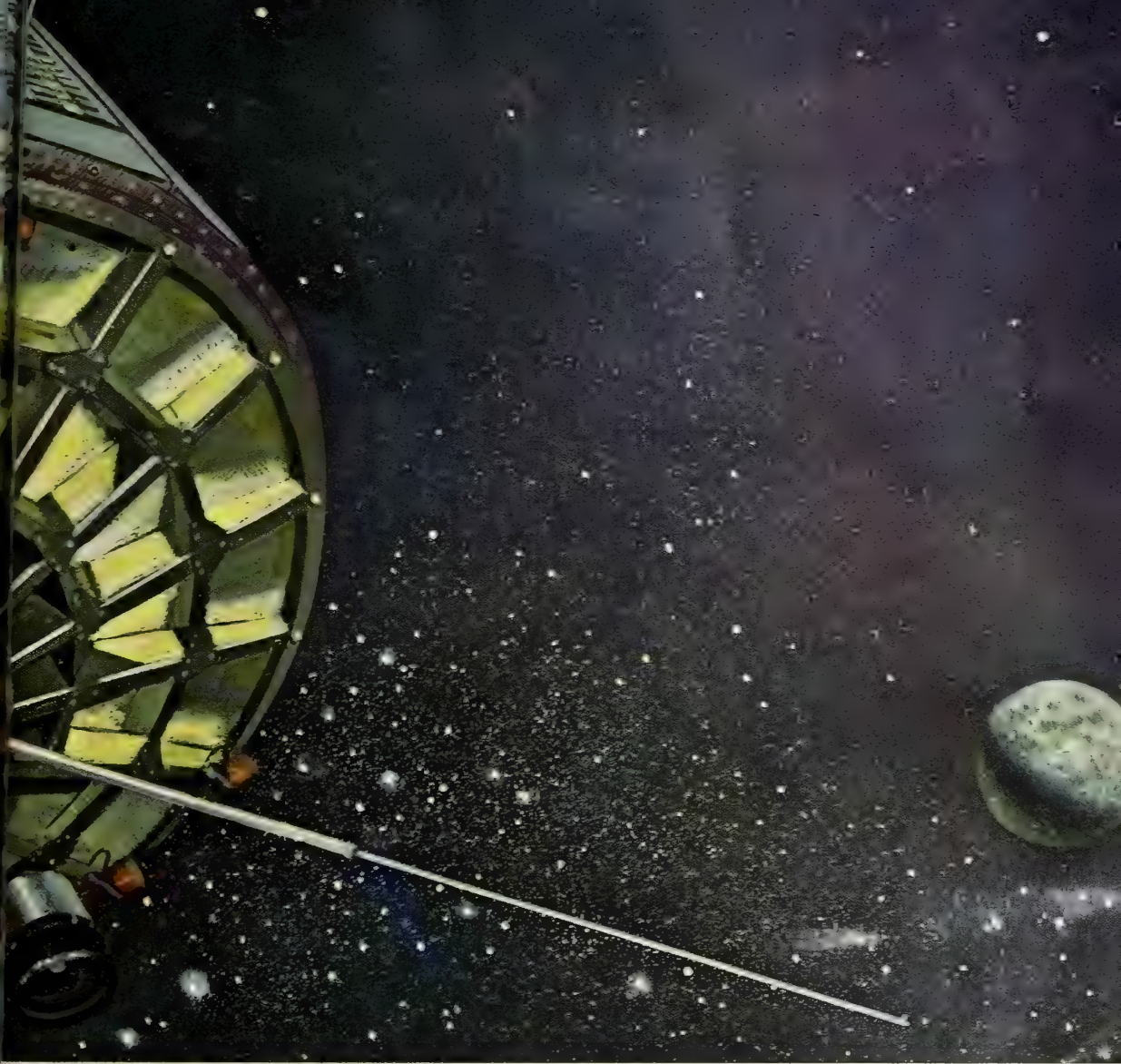


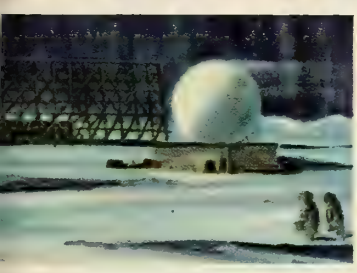
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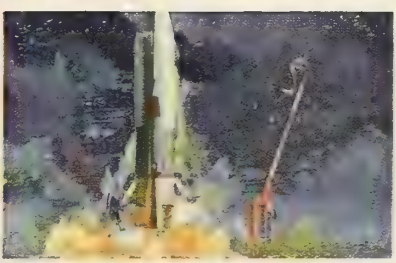




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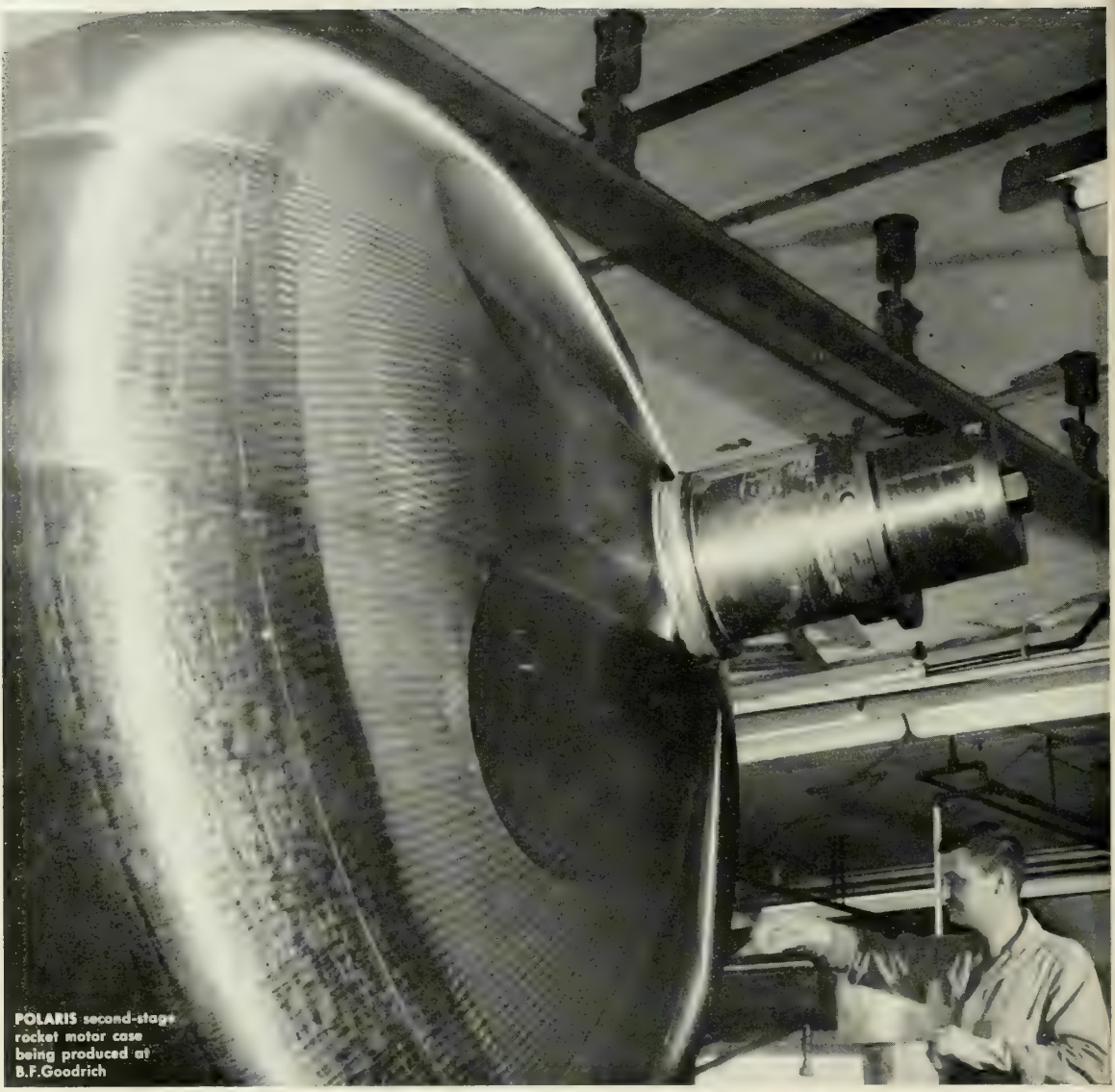
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# SFR Knowledge Can Cut Shielding

***Douglas scientist explains how 12 years' study shows less protection needed in June, December***

**by John F. Judge**

RADIATION SHIELDING for manned lunar missions can be considerably reduced by applying current knowledge of solar-flare radiation events.

A. D. Goedeke, Chief, Space Physics Group, Douglas Aircraft Co., Inc., told the Annual Meeting of the Institute of Environmental Sciences in Washington, D.C., that this was especially true for missions planned for the months of December and June.

Goedeke said there is a semiannual variation in the occurrence of solar-flare radiation (SFR) events which has maxima near the equinoxes and minima in June and December—as observed in the Northern Hemisphere.

In addition, there is a direct relationship between sunspot number and the number of SFR events. The frequency of occurrence of SFR events exhibits an 11-year variation which is in phase with the sunspot cycle.

Another associated peculiarity is that the form of monthly distribution of SFR events correlates closely with that of geomagnetic activity and auroral events.

All of these were derived from studies over the past 12 years.

• **Sun storms**—A solar flare, sometimes referred to as a chromospheric flare, is a short-lived sudden increase in Hα (6563, A, red) intensity occurring in the neighborhood of a sunspot. In addition to the bright Balmer lines of hydrogen and the lines of ionized calcium, the flare produces emission lines of HeI, FeII and other metallic elements.

Visual studies have revealed that flares are relatively flat structures extending parallel to the solar surface. The thickness is three to four times the thickness of the chromosphere, with the uppermost portions penetrating into the corona. In time, the flares are essentially stationary in their position.

Solar flares are classified according to their areas on the disk of the sun at maximum brightness. This area is expressed in millionths of the visable hemisphere or in square degrees (1 sq. deg. = 48.5 millionths = $3.13 \times 10^4$ km$^2$).

In square degrees, a Class 1(−) solar flare would be anything less than 2.06 sq. deg. Similarly, a Class 1 is 2.06 to 5.15 sq. deg., a Class 2 is between 5.15 and 12.4, a Class 3 falls into 12.4 to 24.7, and a Class 3 is anything greater than 24.7 sq. deg.

Goedeke pointed out that the occurrence of solar flares is not as rare as some might think. During the International Geophysical Year, a total of 6762 flares were observed. Of these, only 21 were associated with the arrival of solar protons in the earth's vicinity. Goedeke assumes that only major flares of Class 2 or greater are the cause of the observed ionizing radiation increases. Then about 1 out of every 25 results in an SFR event.

• **Periodic manifestations**—The peculiarities in the frequency of occurrence of SFR events are presently difficult to explain, says Goedeke. It has recently been shown that the maxima of the semiannual variation in geomagnetic activity occur at the equinoxes, and that the daily variation can be directly correlated with the daily change in the obliquity of the earth's magnetic axis relative to the earth-sun line, along which the low-energy solar corpuscles are assumed to travel.

Considering the correlation of the monthly distribution of SFR events, geomagnetic activity and auroral events, Goedeke says it is reasonable to assume that the cause of the semiannual variation is the same for all three cases. He advanced five mechanisms to explain the periodicity:

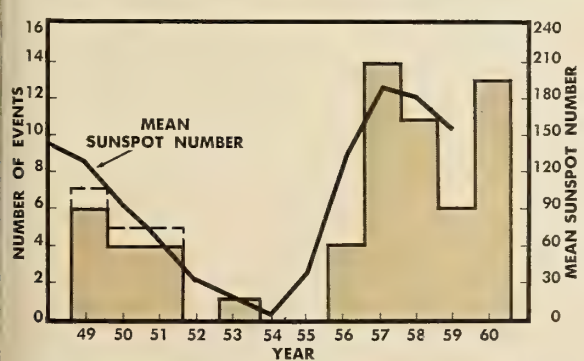
—A consequence of observational techniques;

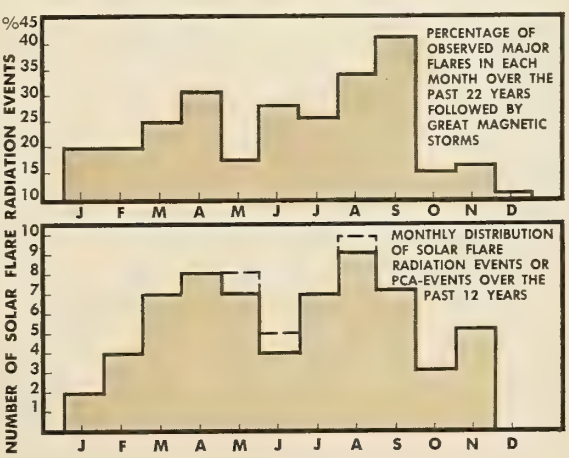
—True solar phenomena;

—Periodic changes in the interplanetary magnetic field (Combination of terrestrial and solar fields);

—The heliographic position of the earth relative to the active sunspot bands; or

—A combination of two or more




*CORRELATION BETWEEN sunspot number and SFR events is obvious from the plot above. RIGHT: Similarity of monthly magnetic storms preceded by major solar flares with the SFR events of the last 12 years is apparent here. PCA (polar cap absorption) events furnish direct evidence for SFR events.*



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of the above four factors.

Goedeke concentrates on the third and fourth possibilities.

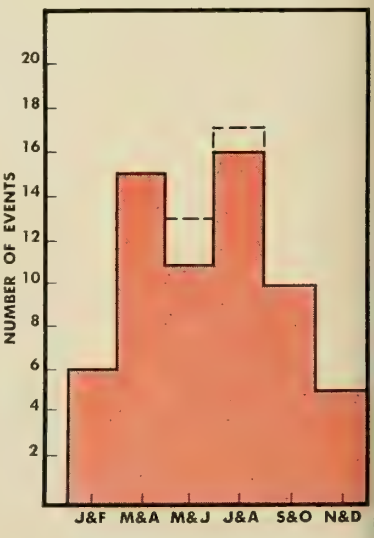
The third mechanism relies on the changes of the interplanetary magnetic field which may be due to changes in both the solar and terrestrial fields. As solar flare protons are thought to travel along magnetic lines of force which emanate from the sun, any combination of the solar and terrestrial fields would have to produce a magnetic barrier, essentially blocking proton passage during June and December.

Since proton energies up to 500 mev are present during SFR events, Goedeke says it is doubtful that such a barrier could have the proper orientation and strength to repel solar protons.

But such a mechanism may be plausible for explaining the variations in auroral events and geomagnetic activity.

The fourth possibility is more attractive, because simple geometry can be used. Practically all of the solar sunspot activity falls within two zones parallel to the equator and within ±45° latitude. The zones have an average width of 15–20° and rarely reach the equator. The first spots of a new cycle occur at about 30° N and S. At activity maximum, the zones reach ±15° latitude, while the last spots in the cycle appear at about ±8°.

The migration of these zones in latitude follows a periodicity of 11.1 ±0.4 years. This is more regular than the sunspot cycle. The facts that active sunspot regions rarely reach the solar equator and that the earth passes through the plane of this equator on June 5 and December 5 appear logically related.




*BI-MONTHLY distribution of PCA events between 1949-1960 exhibits the semiannual variation which could be used to avoid heavy shielding in manned flights.*


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Goedeke says that both theories are attractive—from different points of view. Future space experiments will prove one or the other correct or, quite possibly, both wrong.

The Douglas physicist urges concurrent measurements of low-energy particles and magnetic field variations in the plane of the ecliptic and 30° out of this plane. Such investigations would greatly increase our present understanding of the interplanetary medium and solar magnetic fields.

Several "solar bursts" were included in Goedeke's discussion of the SFR event frequency. These bursts differ from the average solar flare radiation in that the energy spectrum extends into the Bev region and geomagnetic activity is unusually high and world-wide.

From 1942 to date, a total of 7 solar bursts have been observed. Taken separately, little can be said about their frequency of occurrence due to the appearance of only 7 in 19 years. Goedeke points out that no such burst has ever been observed to occur at the maximum of a sunspot cycle. Five events occurred on the descending leg of a cycle and the other two on the ascending leg. This is a tendency of SFR events in general.

Goedeke feels that another complete cycle must be monitored before any conjecture can be made concerning the relation of solar bursts with the sunspot cycle.

• **Avoidance techniques**—Utilizing the semiannual variation and K. A. Anderson's technique for predicting the occurrence of an event 2–4 days in advance, short-term term missions may not require burdensome shielding.

The prediction technique will not be effective to any large degree except as a warning device with respect to longer-term flights. The annual variation also offers little hope in cutting down shielding demands for Mars-type trips.

But the 11-year cycle of SFR events which follows in phase the sunspot cycle might render shielding a waste of payload capacity during periods of minimum solar activity. For instance, only one small event occurred during the 1952-1955 interval.

This would imply that manned space missions should commence in the 1963-65 interval, which, says Goedeke, may be premature in regard to vehicle ability.

Assuming that the earth-sun geometry in relation to the sunspot bands is the cause of the periodic variations in geomagnetic activity, auroral and SFR events, it may be reasonable to conduct long-term missions within the plane of the solar equator. The possibility of such an avoidance technique may prove fruitful, Goedeke says, but little reliance can now be placed in its use. ❖





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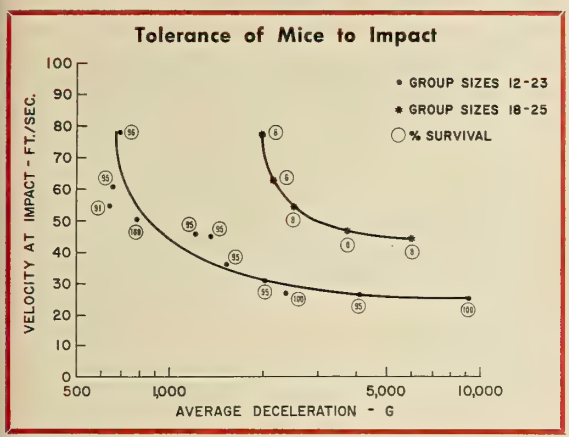
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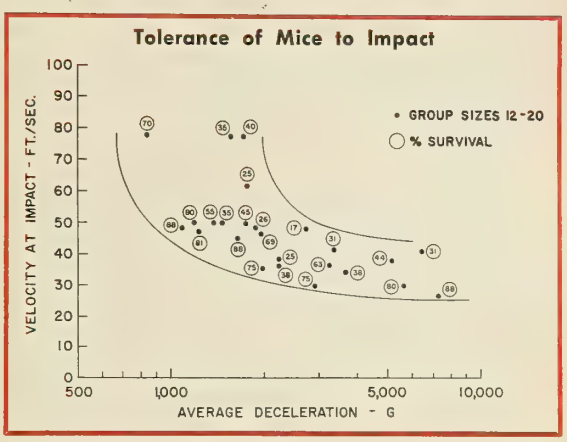


Circle No. 10 on Subscriber Service Card

# Mice Impacted to Save Astronauts




*SURVIVAL RATES of "dropped" mice in two separate groups indicate that small, restrained animals can tolerate impact*




*velocity of about 19 mph and deceleration of 650 g's, up to about 31 mph impact velocity and 1970 g's. (Graphs by GE.)*

**by Heather M. David**

MOST STARTLING of all laboratory research programs on the effects of spaceflight probably is being conducted at General Electric's Missiles and Space Vehicles Department in Philadelphia.

Visitors to the multi-storied Chestnut Street building are apt to be startled by the sight of a group of white-coated technicians on their knees peering into the depths of an elevator shaft. But they aren't examining the fate of some hapless colleague, as one might fear, but carrying on highly calculated, objective research.

Subjects of the experiment are some 700 white mice who are giving their all to help plot the chances of survival for astronauts impacting on the earth's surface after spaceflight.

The tiny subjects—all weighing between 11 and 21 grams—are encased in snugly fitted plastic tubes, loaded on a carriage at the top of the elevator shaft and dropped some 100 feet to the bottom.

The carriage is guided in its fall by a cable strung vertically from the top of the drop shaft to a lead-covered anvil on which it impacts. The mice are positioned so that they receive the impact on their backs.

• **Impact tolerance limits**—The Life Support Operations group came up with these results after testing 744 mice: All the mice could survive an impact velocity of 27 feet/second (19 mph) and deceleration of 650 g's. None of the mice could survive impact velocity of 45 feet/second (31 mph and 1970 g's. The charts show the percentages of mice which survived within these limits.

Some experimental work showed that for magnitudes below these values, tolerance could be expected. Animals survived impact velocity of 78 feet/second (55 mph) for deceleration less than 650 g's and 9300 g's for velocities less than 27 feet/second.

According to project leader Dr. Armand Gold, almost all the mice respond in "an all-or-none manner." That is, they die within 30 seconds or live to survive indefinitely.

Gold's group controls the magnitude of inertial loads and rates of onset by inserting compressible lead stopping devices of different shapes and thicknesses on the anvil. They calculated average deceleration from the standard formula

$$G = \frac{V^2}{2S \times 32.2}.$$

G is the applied decelerative force in multiples of the force of gravity, V is velocity (feet/second) at impact, S is stopping distance (feet) and 32.2 is the constant representing deceleration due to gravity (feet/second$^2$).

Post-mortem examinations seem to indicate that death in the restrained mice resulted from sudden displacement of the central nervous system, particularly of the brain. The tests apparently bore out the fact that animals receiving high g forces in the transverse position —from back to chest—survive with the fewest injuries.

Although there has been evidence of some hemorrhaging in the lungs, spleen and surface of the cerebrum of the mice which were killed by fall, the extent was not considered to be fatal. Dr. Gold also said that the hyperbolic shape of the tolerance curve indicated that there was only a single factor causing death.

The brief duration of impact in the experiments (up to several milliseconds) has led the GE group to conclude that tissues may respond in a way similar to that of inert materials under mechanical stress. Injuries (for durations up to 0.2 seconds) are believed to be dependent on physical properties such as elasticity, viscosity, frequency response, tensile and shearing strength and compressibility of tissues.

• **What about humans?**—The General Electric group generally feels that humans can be expected to react in much the same way as smaller animals, provided the restraint system system is adequately designed.

A human tolerance curve constructed from crash, accidental fall and rocket sled data asymptotes at approximately 80 feet/second (56 mph) and 22 g's. Murray Kornhauser, a member of the GE Life Support Operations group, constructed this theoretical sensitivity curve.

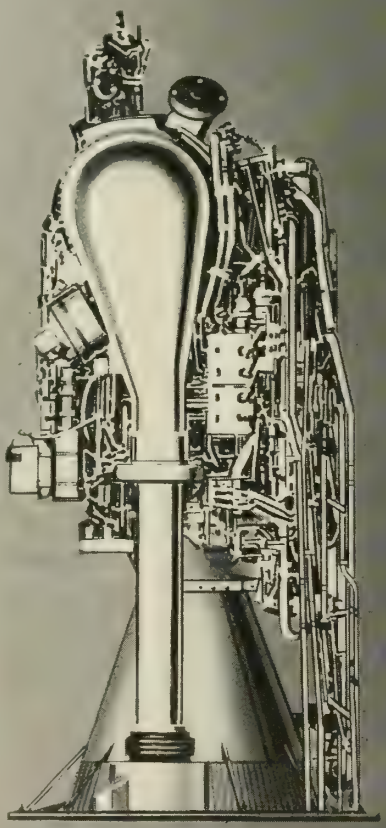
The data gathered in the tests will eventually be incorporated in the design of restraint and escape systems for MSVD projects. ❖

THIOKOL PLANNING POWER AND MANAGERIAL

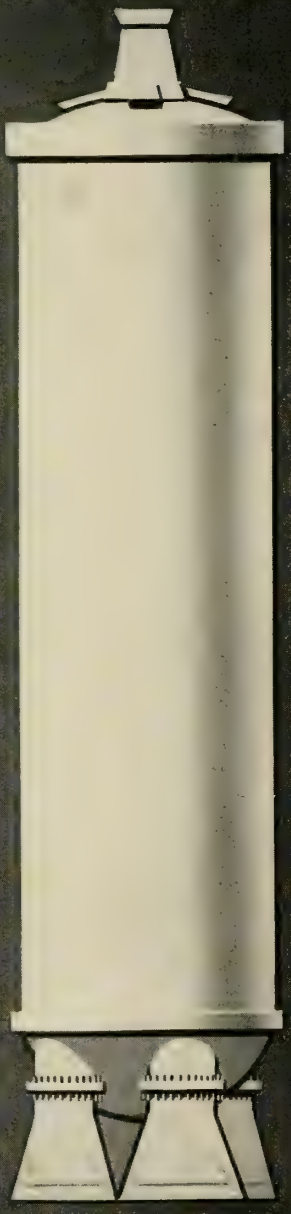
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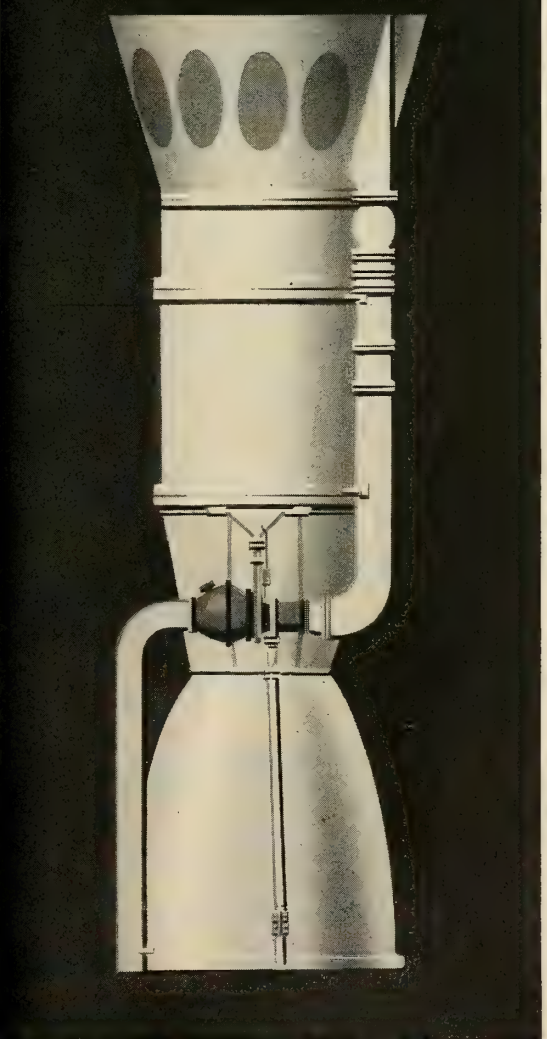


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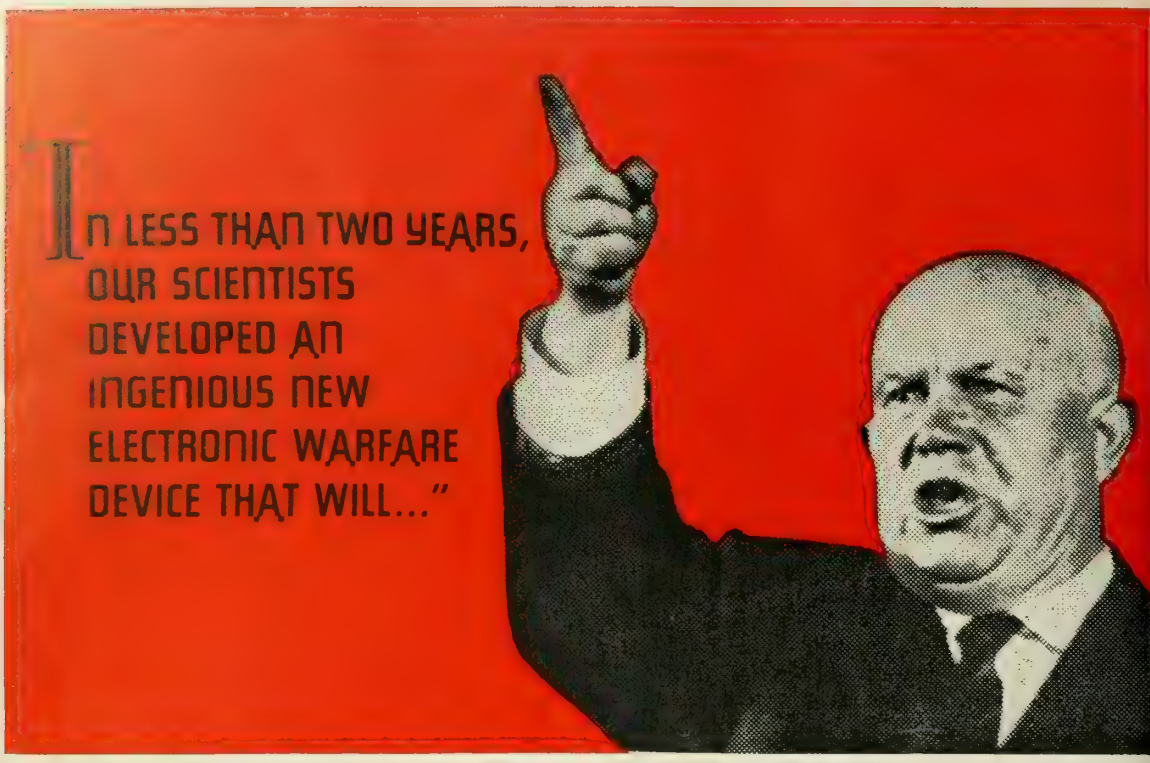
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## Russian Shots show single purpose

*(Continued from page 16)*

The three "Cosmic ship" launchings of last summer and fall probably ironed out all of the major bugs—at the very least, they more than proved the feasibility of the approach. A certain degree of confidence resulted from these shots—as evidenced by the fact that Gagarin's flight was announced while still in progress.

• **More than boosters**—The Russian capabilities in boosters are well known. Each of these space cabins weighed in the neighborhood of 10,000 lbs. About five times the weight of the *Mercury* capsule and twice that of *Dyna-Soar*. Here there may be some clues as to how the Russians approach the re-entry aspect of manned flight as well as life support and communications.

But the sheer size of the boosters is simply another outcome of a well-planned, integrated program. In the years since *Sputnik I*, the Russians sent three probes toward the moon, one of which went into a solar orbit. In February, the Venus probe was launched.

It seems at first glance that these are separate from the train of events culminating in Gagarin's flight. But if the single-minded Russian approach to space involved man from the very start, then these may well be included.

It is true that U.S. satellites are more numerous and have supplied an enormous amount of information. But the Russians may well have gathered only that data they deemed absolutely necessary as their man-in-space program developed.

Taking this narrow viewpoint, the *Luniks* and the Venus probe could indicate the emergence of a broadened manned space effort—one in which the Gagarin flight constitutes but a single element.

If this is the case, it means that the Russians are actively pursuing immediate goals far beyond the orbiting of one man around the earth. The world's reaction to Gagarin's flight contains ample evidence that the feat was not unexpected. But precisely when did the directors of the Soviet space effort adopt this view? And how high did they then raise their sights?

Perhaps the three *Luniks* had nothing to do with manned flight. And maybe the Venus probe was an "art for art's sake" affair. ⌗

## The Soviet Pattern!

| Soviet Designation | Launch Date | Total Weight in Orbit (lbs.) | Remarks |
|---|---|---|---|
| Sputnik I | 10-4-57 | 8,616 | 184 lb. payload—Earth's first artificial satellite. |
| **Sputnik II** | **11-3-57** | **11,000** | **1,120 lb. payload—Biomedical satellite.** |
| Sputnik III | 5-15-58 | 10,275 | 2,925 lb. payload—Physical data satellite. |
| Cosmic Rocket I | 1-2-59 | 796 | Lunik I (Mechta), Solar Orbit, passed within 4,000 mi. of moon. |
| Cosmic Rocket II | 9-12-59 | 860 | Lunik II, impacted on moon Sept. 13, 1959, after approximately 35 hours flight time. |
| Automatic Interplanetary Station I | 10-4-59 | 614 | Lunik III, photographed far side of moon, Lunar Magnetic Data, Micrometeorites. |
| **Cosmic Ship I** | **5-15-60** | **10,009** | **Sputnik IV—Near circular orbit of pressurized cabin, life support checkout. Failed to re-enter properly.** |
| **Cosmic Ship II** | **8-19-60** | **10,143** | **Sputnik V—Space Cabin and life support system containing 2 dogs, and an assortment of rats, mice, flies, etc. Recovered successfully Aug. 20, 1960.** |
| **Cosmic Ship III** | **12-1-60** | **10,614** | **Sputnik VI—Space Cabin and life support system containing 2 dogs. Failed to re-enter properly.** |
| Sputnik IV | 2-4-61 | 14,295 | Sputnik VII—No details announced by USSR but possible attempt at Venus. |
| Automatic Interplanetary Station II | 2-12-61 | 1,419 | Venus Probe—Radio contact lost Feb. 27, 1961, but may have been restored. |
| **Cosmic Ship IV** | **4-12-61** | **10,460** | **Sputnik VII—Space Cabin and life support system containing one man. Recovered successfully after one earth orbit April 12, 1961.** |

## Soviet Spaceman

*(Continued from page 15)*

"space platform or even a base on the moon."

In the House, Chairman Overton Brooks (D-La.) of the House Space Committee said NASA's budget should be increased nearly another half-billion dollars. Rep. Victor Anfuso (D-N.Y.), a Space Committee member, said the NASA 10-year space program should be accomplished in five years.

Members of both the House and Senate said the Soviet space flight can be expected to have an immediate impact on East-West affairs in trouble spots from Latin America to Asia. Informed government officials said the United States could expect Russia to use the space flight as a psychological weapon in swinging African and Asian leaders into the Communist Bloc.

Even as the wave of dismay swept through parts of official Washington, Moscow was preparing to receive Comrade Gagarin in triumph and Soviet Premier Khrushchev was boasting of the eventual triumph of Soviet Communism over the West.

The Soviet victories that had begun on Oct. 4, 1957 with the launching of Sputnik I had culminated despite the disparaging comments from American leaders with Gagarin's flight of April 12, 1961.

Now, the Soviets forecast they would reach out for the moon ahead of the United States. Who was confident that they would be proved wrong? ⌗

### Messages From Space

***Spaceman Yuri Gagarin, in a series of four messages radioed from space, apparently found his 108 min. flight around the globe rather enjoyable. But the messages shed little light on conditions in space.***

***"I can see the earth," he told Soviet scientists on the ground. "Visibility is good. I can hear you excellently."***

***"The flight goes well," he said in another message. "I can see the earth. I can see everything. Some of the space is covered with clouds."***

***Interference made it hard to hear Gagarin.***

***His third message said: "I continue the flight normally. Everything works excellently. I am going farther."***

***"I feel fine," the fourth message said. "My spirits are high. I continue the flight. All goes on well. The machine works normally."***

# Minuteman's Big Emplacement System




*MINUTEMAN HOUSED IN 63-ft.-long truck container is raised to vertical in first public demonstration at Bendix-Pacific.*

NORTH HOLLYWOOD, CALIF.—Getting the first operational *Minuteman* into place at its silo will take between four and six hours—but this time will be sharply reduced with experience.

Bendix-Pacific, responsible for emplacement equipment for the Air Force ICBM, says it will need about two hours to carry out its share of the emplacement job when the solid-fueled bird becomes operational in mid-1962. The remaining time will be required for miscellaneous operations by Boeing Airplane Co. personnel.

Bendix-Pacific has delivered four complete emplacement systems to Boeing, assembly and test contractor for *Minuteman*, and has just received a contract for five additional systems. The follow-on contract is for slightly less than $1 million, and calls for delivery of the first unit this fall.

Weighing 108,000 lbs. gross, the transporter-erector equipment consists of a General Motors tractor and rear carriage, a Cessna missile container, and the Bendix emplacement system.

• **Emplacement**—Four principal subsystems make up the emplacement system: A major hydraulic power supply, two erector actuators, a hydraulic-powered mechanical hoist, and an electrical control panel to sequence all steps in the operation.

The main hydraulic power supply is driven by the tractor engine and develops 20 horsepower at 10 gallons per minute and 3000 psi. The system has a 150-gallon reservoir including a temperature control switch preventing the power supply from operating if the fluid is not the correct temperature. The unit has a dual-pump feature to ensure reliability.

The dual erector actuators consist of three telescoping sections, each extending 35 feet and capable of lifting 108,000 lbs. With a wall thickness of about ⅜-in., the tubes lift the container from horizontal to vertical in about 12 minutes.

The hydraulic-powered mechanical hoist, produced for Bendix by Western

*(Continued on page 44)*




# ...key to life

Water means power . . . water means raw materials . . . water means the life of the maritime nations. Still—man is ignorant of the mysteries of the oceans . . . he is only beginning to search the depths.

General Motors Defense Systems Division is vitally interested in all ocean phenomena. For example, new nuclear submarines and their cargoes of ballistic missiles constitute one of America's most effective deterrents against attack. Water—and the *control* of water—is vital to national defense.

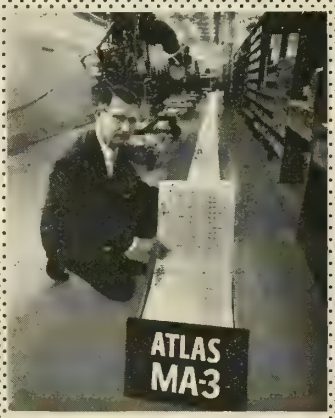
Scientists and engineers in the laboratories of the Defense Systems Division are also hard at work in land, aero-space, astrophysics, biological sciences, oceanography, nucleonics, and basic research projects.

DSD is dedicated to serving the Defense Department and other government agencies, in cooperation with many different branches of industry and scientific groups, in fields of fundamental research and engineering through the coordination of knowledge, abilities, ideas and hard work.

General Motors is proud to contribute, through the growing Defense Systems Division, to the strength of America and human progress. Top-level scientists and engineers in all of these specialized fields will find rare opportunities and challenging assignments in this fast-growing organization.

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Rocketdyne, the pioneer in rocket science, was first with power for America's long range ballistic missiles—first with power for outer space. In establishing this technological leadership, Rocketdyne developed new management concepts at every level of operation, from early design through final testing. The result is outstanding technical achievement at the lowest possible cost.

In data processing alone, advanced techniques are saving engineers hundreds of hours of experimentation and testing and have contributed to a 37 percent reduction in Atlas engine costs for the Air Force. An intracompany communications network links test stands and research laboratories in Missouri, Texas and California; gives management the daily status of every program—whether it's on schedule, what parts are in short supply, how the production line is performing.

Through research, engineering, and management, Rocketdyne is constantly at work not only to increase thrust performance and develop new propulsion techniques, but at the same time to reduce costs all along the line.

*34 of America's 38 successful satellites and space probes have been launched by Rocketdyne engines.*

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(Continued from page 40)

Gear Corp., can lift 100,000 lbs., or 50 times its own weight. The entire hoist assembly weighs approximately 2000 lbs. *Minuteman* is hoisted by 48 strands of ¼-in. cable, which also handles all the equipment attached to the missile.

*Minuteman* is officially listed as being in the 60,000 to 70,000 lb. weight class.

The electrical control panel sequences and controls the 67 steps in the operation, including 11 classed as "critical." Major phases include raising the container from horizontal to vertical (12 minutes), traversing the missile within its container to separate it from its handling dollies (7 minutes), lowering the missile to the launch ring in the silo (35 minutes), and return of the container to horizontal on the transport carriage.

Traversing the missile away from the floor of the container moves it away from all equipment used while the transporter and missile are horizontal. This operation shifts the top of the vehicle 13 inches and the bottom, or first stage skirt, four inches. The missile is then clear of all obstructions when it is lowered through the container. The dollies are secured to rails in the container.

• **Safeguards**—Safety factors in the control panel prevent the operator from advancing to the next critical step until the previous step is completed. Eleven such critical steps are in the series of 67. Additionally, if the operation is begun and a failure occurs in part of the system, the equipment must be capable of either lowering the missile into the silo through a manual override capability or returning it to the container. The Air Force insists that the temperature-sensitive *Minuteman* not be exposed to an uncontrolled environment for excessive periods.

Minimum life span of the transporter-erector unit is 500 emplacement cycles, and Bendix has set up tests to 750 cycles to prove dependability. Governing factor is apparently the hydraulic seals and similar components. A refitting program would put a unit back in operation.

The base plate used to support the missile during lowering is left in the silo and the vehicle is subsequently launched from it.

Accuracy of the emplacement is not a critical factor, since a rotatable ring supporting the missile in the silo is used later to orient the guidance system precisely. The Bendix emplacement system puts the vehicle within two degrees of rotational angle; then adjustments are carried out. Vertical alinement is also adjusted after emplacement is completed.

The Cessna-built container maintains a controlled environment for the missile by automatic controls and lightweight thermal insulation. Made of magnesium and aluminum, it weighs 8500 lbs. empty, is 8 ft. wide, 8 ft. high and 63½ ft. long. In transit, its top is 13 ft. above the highway.

General Motors' tractor and carriage use a V-12, 275-hp gasoline engine and a five-speed main transmission with three-speed auxiliary transmission. Road clearance is 9 in.; overall tractor height is 6 ft.

The test silo used by Bendix-Pacific is smaller than the operational silo, being 9 ft. across and 65 ft. deep. The operational version is 12 ft. wide and 85 ft. deep. A 75,000-lb surplus test vehicle from the Edwards AFB firings that proved out silo configuration is used to check out the emplacement system.

The guidance system for the missile is transported in place, so that no extensive checkout equipment will be necessary at the silo to re-test it after the thorough factory tests are completed. AF spokesmen estimate that shock on the missile during transit is about ⅓ g —far less than the shock of launching.

Only basic checkout equipment will be used at the silo, to ensure that no disruption in circuitry has been caused by transportation. The missile is slated to be carried from the assembly plant at Hill AFB directly to the silo for emplacement.

• **Simple transport**—Highways are expected to present no problems to the transportation of *Minuteman*, since a thorough survey was conducted on all roads expected to be used in potential site locations. The maximum gross weight of the transportation system—108,000 lbs.—was consciously designed to get under the strictest highway maximum-weight regulations in the country.

By some roundabout routing, the Air Force says, it can get *Minuteman* to its silos with no more than strengthening of a few culverts. No bridges will have to be moved or other similar steps taken.

Highway safety has been assured by deliberately trying to ignite the propellant through every possible accidental means. The Air Force has fired rifles into the solid-propellant rockets, put blazing gasoline containers under them, and even fired a shaped explosive charge into the missile to try ignition susceptibility. The shaped charge merely ruptured the case and made a crater in the propellant. No accidental ignition was experienced.

The Air Force adds that the transporter system is designed so that there is no danger of capsizing.

Unrefueled range of the tractor is 250 miles. The unit is designed to climb a grade of 17%. ⌗

## Ajax Radar Simulators To be Changed for Hercules

RADAR SIMULATORS (15D2's) built for training *Nike-Ajax* radar operators will be modified for *Nike-Hercules*.

A bidders conference was held recently at the Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala., to brief contractors on the new requirements.

Shortly thereafter, the Pentagon quickly spiked rumors circulating in Washington that the "updating" was cover-up for the fact that none of the *Ajax* simulators had ever performed as designed.

The trainers were built originally by ITT Federal Division from a prototype built by Aircraft Armament, Inc. Ninety-six van-type units were built at a cost of about $10.5 million, according to an Army spokesman.

Original procurement was handled by Naval Training Devices Center, Port Washington, N.Y. for Continental Army Command at Fort Monroe, Va. ARGMA is now responsible for support and production procurement for the *Nike* installations.

The modified system, to be known as AN/MPQ-36, will be improved to handle more advanced target problems than confronted the older short-range *Ajax*. Details of requirements have not been released but two in particular are known: the need for simulating targets employing sophisticated electronic countermeasures and supersonic attack vehicles—missiles or aircraft.

Two of the old 15D2's have been modified, Army said, and subsequent tests have proven feasibility for the new *Hercules* mission.

It is reported that the total numbers of systems to be modified will depend on the cost per unit proposed by the winning contractor. ⌗

## Smoke Signals Aid Army Missile Tests

ARMY TEST engineers are using mid-air puffs of smoke to determine effects of vertical winds on missiles.

The smoke puff is created by firing aloft a small container of smoke-producing agent timed to burst at a given height along the test missile's flight path. By studying movie films of the test, engineers can compare the performance of the missile against the visible record of the air currents acting on the smoke.

The technique provides precise wind measurements at altitudes up to 1900 feet. It is being used in missile firing tests at Redstone Arsenal and White Sands Missile Range. ⌗




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## Complete SNAP 2 Unit Due for Early Ground Test

A GROUND TEST of the complete *SNAP 2* power supply, designed to supply up to 3 kilowatts for spacecraft needs, will take place later this spring.

A 200-lb. reactor designed as a prototype for *SNAP 2* by Atomics International Division, North American Aviation, went critical on April 4. The reactor, designated S2DS, will be mated with a power conversion unit composed of a liquid sodium-potassium heat exchanger and a mercury-boiling turbine.

After completion of the test program, a system with flight configuration will be ground-tested in a satellite nose cone, the Atomic Energy Commission reported.

The S2DS reactor is the second built for the *SNAP 2* program and the first designed to be tested with a conversion unit, components of which are being developed by Thompson Ramo Wooldridge. ⌘

## EIA Blasts Section Of Small Business Bill

ADMINISTRATIVE cooperation between the Small Business Administration and defense procurement agencies will do more for small business than legislative action, the Electronics Industries Association contends.

Objecting to parts of the pending Proxmire bill (S 836), C. J. Harrison, chairman of the EIA Small Business Committee, said that the proposed legislation is not "an effective approach" in increasing small business participation in government subcontracting.

Principal point of contention is section 8 of the Proxmire measure. If this becomes law, Harrison said, the SBA would become an additional statutory contracting party, resulting in delays in the award of prime contracts and in the selection of subcontractors. It would, he added, "further complicate an already cumbersome and slow procurement process." ⌘

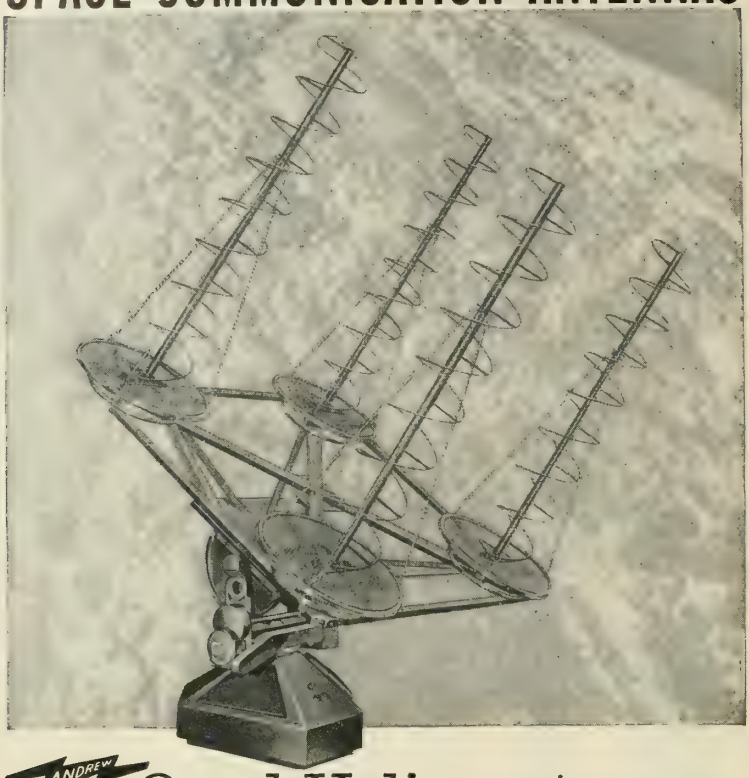
## Fairchild Semiconductor Expands Marketing Set-up

MAJOR EXPANSION of Fairchild Semiconductor Corp.'s marketing department advanced regional sales managers in Los Angeles, Chicago and New York to new positions at the Mountain View, Calif., headquarters.

Robert F. Graham became special product-micrologic sales manager, John F. Ready took over diode sales, and Robert W. Dugan was promoted to head transistor sales.

Replacing them were district sales managers Alan J. Bayley, Robert L. Major, and James P. Paris. ⌘

# SPACE COMMUNICATION ANTENNAS



ANDREW

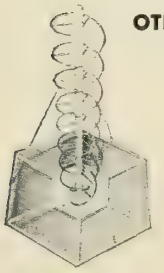
## Quad-Helix antenna

### tracks long and medium-range missiles

Telemetry circuits between missile (or satellite) and ground station are reliably maintained with the ANDREW Quad-Helix Array. This system offers low VSWR, high gain, and easy control.

Gain is 17.5 db at 265 mc, 14.5 db at 215 mc. VSWR is less than 2.0:1 across this range. Polarization is right hand circular; impedance 50 ohms. Counterbalanced rotator provides 180° elevation and 720° azimuth tracking at speeds from 0° to 30° per second.

Optional remote control unit regulates speed and direction.



**OTHER ANDREW GROUND-AIR ANTENNAS**

**TRI-HELIX ANTENNA**

880-990 MC 17.5 DB GAIN TYPE 81068

**HELIX ANTENNAS**

| FREQUENCY | GAIN | TYPE NUMBER |
|---|---|---|
| 108-132 mc | 12 db | H 19110 A-1 |
| 215-265 mc | 10.5 db | H 50140 A |
| 215-265 mc | 13 db | H 19110 A-2 |
| 260-320 mc | 13 db | H 19110 A-3 |
| 320-400 mc | 13 db | H 19110 A-4 |
| 400-500 mc | 12 db | H 19110 A-5 |



**DISCONE ANTENNAS**

| FREQUENCY | TYPE NUMBER |
|---|---|
| 25-50 mc | 50154 |
| 50-108 mc | 51150 |
| 108-215 mc | 19050-1 |
| 215-420 mc | 19050-2 |
| 420-1000 mc | 19050-3 |

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# —names in the news



FIRESTONE



ECONOMOU

**George A. Economou:** Appointed manager, optical instrumentation, J. W. Fecker Division of American Optical Co., Pittsburgh. Prior to joining Fecker, Economou was senior staff engineer at the Perkin-Elmer Corp.

**Edward F. Nauman:** Named general manager of Wasatch Division of Thiokol Chemical Corp., Ogden, Utah. Other Division appointments are: **John Higginson,** manager of finance and administration; **Jack Buchanan,** manager of research and development; and **L. C. Taylor,** manager of contracts and customer services.

**Louis L. Reasor** and **Edward A. Hayes:** Appointed manager and assistant manager, respectively, of Hughes Aircraft Company's Tucson Division.

**Dr. T. Keith Glennan:** President of Case Institute of Technology, rejoins the board of Clevite Corp. Dr. Glennan was a Clevite director for five years prior to his appointment as first administrator of NASA in 1958.

**Neil E. Firestone:** Appointed general manager of General Electric's Flight Propulsion Division, Evendale, Ohio. Former general manager of the large jet engine department, Firestone has been with GE since 1942.

**Abel DeHaan, Jr.:** Elected vice president of Tracerlab, Waltham, Mass. To continue as general manager of the company's Reactor Monitoring Center, Richmond, Calif. Prior to joining Tracerlab, he was a radiochemist at Oak Ridge National Laboratories.

**Robert B. Craven:** Former staff engineer of the Massachusetts Institute of Technology Instrumentation Laboratory appointed group leader, instrumentation at Aerospace Research, Inc., Cambridge.

**Martin J. Ruthford;** Named director of military marketing for Capehart Corporation's Military and Industrial Division Richmond Hill, N.Y. Previously, Ruthford was a partner in Senior Associates, Monmouth, N.J.

**John H. Vye:** Appointed assistant general manager of Remington Rand Univac Military Department, St. Paul. **Lawrence W. Reid** succeeds Vye as director of manu-



VYE



FROMM

facturing. **Richard L. Gehring,** former supervisor of data systems, named manager of field maintenance and training.

**William J. Hilty:** Appointed exposition manager in communications department of American Society for Metals. **A. P. Ford** named director of communications, and **Fred Stanley** advertising manager for ASM periodical publications.

**J. Ward Wright** and **R. L. Tibbs:** Named assistant manager and staff representative for electronic requirements, respectively, at The Martin Company's Huntsville, Ala. office.

**Winfield E. Fromm:** Former head of Space Technology and Research Department, Airborne Instruments Laboratory of Cutler-Hammer, Inc., appointed director of AIL's Research and Systems Engineering Division. Fromm succeeds **Eugene G. Fubini,** recently appointed director of research, Department of Defense, Research and Engineering.

**Conrad Kunze:** Joins Otis Elevator Company's Defense and Industrial Division, Brooklyn, as assistant general manager. Kunze has held various executive positions for the past 20 years with Convair/General Dynamics in Fort Worth and San Diego, and with Northrop Corporation, Hawthorne, Calif.

**David C. Trott, Jr.:** Named employment manager of Guided Missiles Range Division, Pan American World Airways, Patrick AFB, Fla.

**Peter N. Lensi:** Joins Hummel Chemical Co., New York, as research director. Formerly Lensi was with Reaction Motors Division of Thiokol Chemical Corp., Denville, N.J., and research chemist at Picatinny Arsenal.

**Herbert Rosenberg:** Named manager of digital circuits department of Marshall Laboratories, San Marino, Calif. Previously at Space Technology Laboratories, he was responsible for the design and construction of space instruments aboard *Explorer VI, Atlas/Able-4* and *-5,* and *Pioneer V* payloads.

**William I. Moore:** Named sales engineer for The Beryllium Corp., Reading, Pa.





actual size

BRISTOL chopper helps put Navy TARTAR on target



. . . **Every component** in the U.S. Navy's TARTAR, newest supersonic surface-to-air guided missile must meet the highest standards for statistical reliability.

No exception is the Bristol Syncroverter* chopper used in the TARTAR's guidance system. The TARTAR, produced for the Bureau of Naval Weapons by Convair (Pomona) Division of General Dynamics Corporation, is slated to form the primary antiaircraft weapon aboard destroyers and secondary antiaircraft batteries aboard cruisers.

The Bristol Syncroverter chopper has a long history as a component in U.S. guided missiles. It's the ideal miniature electromechanical chopper for use in d-c analog computers or wherever utmost reliability is required.

**BILLIONS OF OPERATIONS** have been completed without a failure on Bristol's continuing life tests—aimed at improving the Syncroverter's already superlative characteristics. Just one sample: A group of five choppers, with 400 cps drive and 12v, 1 ma resistive contact load have been going for more than 26,000 hours without failure. That's more than 2.96 years continuous operation or more than 37 billion complete cycles!

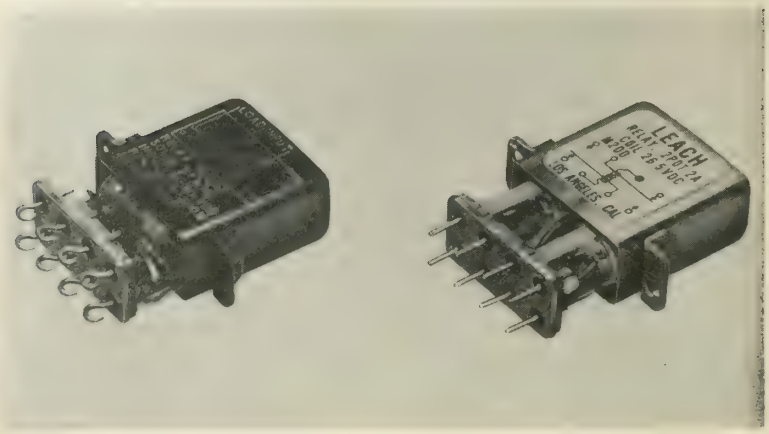
No matter what your chopper requirements, we're sure you can find the model you need among the wide selection of Syncroverter choppers and high-speed relays available . . . including low-noise, external coil types. For complete data, write: The Bristol Company, Aircraft Equipment Division, 150 Bristol Road, Waterbury 20, Conn. 0.15

*T.M. Reg. U.S. Pat. Off.

**BRISTOL** FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS




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## Microminiature Relays

Two microminiature relays—one a half-ounce, high-accuracy solid-state time delay, and the other an MS-approved high-performance rotary crystal can—are available from the Leach Corp.

Where time delays with multiple-output contacts are required, the two can be used in conjunction to perform the work of a much larger conventional two-pole, double-throw timing relay.

The new solid-state device, identified as the TD-181, utilizes zener regulation for guaranteed accuracy under presence of input voltage fluctuation and switching transients, and offers protection against damages from input polarity reversal.

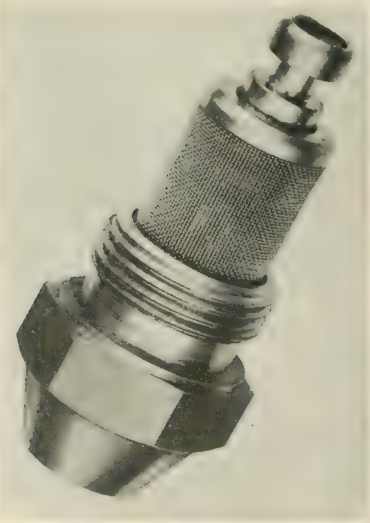
The new crystal can, identified as the M200, occupies less than ⅓ cu. in. and offers high resistance to shock and vibration.

Circle No. 225 on Subscriber Service Card

## Dual Orifice Nozzle

A standard, low-cost, dual-orifice nozzle for gas turbine engines has been developed by Delavan Manufacturing Co.

Basic parts, installation dimensions and materials are standard. Reasonable departures from these standards are available to allow for special flow rates or spray angles. Except for one aluminum seal, all parts are manufactured from corrosion-resistant stainless steel.



Circle No. 226 on Subscriber Service Card

## Reluctance Stepper Motors

Two reluctance stepper motors representing a definite advance over the permanent magnet-type motors are being produced by Instrument Division of American Electronics, Inc. These stepper motors allow stepping in small increments of 15 to 7.5 degrees at the rate of 200 to 550 steps per second.

The two motors work in conjunction with a logic circuit which controls the rate, sequence and direction of the stepping action. They may be driven by electromechanical or electronic logic.

Circle No. 227 on Subscriber Service Card

## Waveguide Switch

A compact single-pole, double-throw waveguide switch for use in RG-51/U waveguide systems (7.05-10.0 kMc/s) is available from Microwave Associates, Inc.

The MA-1064 switches are rated at 300 kW (kilowatts) peak power when operated unpressurized, and at 500 kW peak power when pressurized to 2 atmospheres. Units have been tested to over 400 kW peak power, unpressurized.

A low insertion loss of 0.15 db and a maximum VSWR of 1.10 over the entire waveguide band are important features of these switches.

Isolation in excess of 35 db is achieved by optimum design of internal chokes and by precision machining.

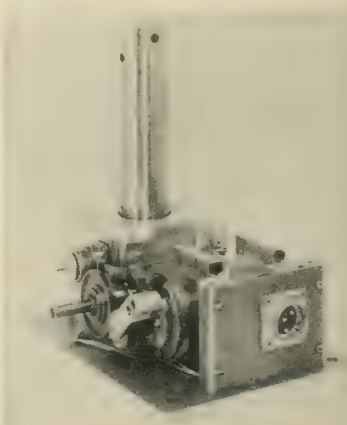
Circle No. 228 on Subscriber Service Card

## Electric Servo Actuator

An 8-millisecond-response electric servo actuator for control of flight surfaces of missiles is available from American Electronics, Inc.

Utilizing a constant-speed miniaturized motor as its source of motion, and a clutch which gives left or right action, each flight control surface is directly connected to its own actuator.

Weight savings of as much as 50% over hydraulic systems for the actuation of control surfaces are claimed in addition to the total elimination of piping, valves, filters, kinkages, accumulators and other plumbing accessories.



Circle No. 229 on Subscriber Service Card

## DC-AC Inverter

Power Instruments Corp. is marketing a transistorized DC/AC Inverter Model PI 1341. This inverter converts



12V d-c to 115 a-c, 60 cps and will handle peak loads up to 1300 watts and continuous loads to 500 watts.

The device is designed to power a-c motors with high peak starting current surges and low starting power factors. Efficiency is 80% at full load.

Circle No. 230 on Subscriber Service Card

## Light Cryogenic Pump

The Cosmodyne Corp. is manufacturing a single-cylinder, high-pressure, cryogenic pump, designed for low and medium flow ranges.

This unit, available from production, delivers liquefied gases, such as oxygen, nitrogen and hydrogen, at pressures up to 10,000 psi and flows up to 4.65 gpm (26,000 scfh of $N_2$).

The pump, although compact and weighing only 42 lbs., is designed for commercial and industrial applications, and features low maintenance operation.

The pump is designed with three separate thermal sections—cryogenic, intermediate and ambient temperatures—separating the cryogenic pumping end from the lubricated drive end.

Circle No. 231 on Subscriber Service Card

# new literature

PIEZOELECTRIC DEVICES—A 16-page illustrated booklet on the application of piezoelectric devices is available from Clevite Electronic Components. Designed to show the principal existing and potential uses of piezoelectricity, the booklet outlines and compares the performance characteristics of all major piezoelectric substances. Text and tables cover piezoelectricity as applied to convert mechanical energy to electrical energy and the reverse. Electromechanical properties and useful service temperature ranges of piezoelectric elements are included.

Circle No. 200 on Subscriber Service Card

CLEANING CHEMICALS—A 14-page booklet describing ultrasonic cleaning chemicals has been issued by the ultrasonic power division of Branson Instruments, Inc. Practically a handbook, it gives extensive information on physical properties of most commonly used cleaning chemicals, as well as suggested applications, working temperatures, and procedures.

Circle No. 201 on Subscriber Service Card

MICROWAVE FREQUENCY—A reference table and band code letters and corresponding microwave frequencies is available from the Applied Dynamics Division of the Atlee Corp. Band codes are cross referenced with identifying sub letters, frequency band limits in kilomegacycles/seconds, and equivalent wavelengths in centimeters.

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**The Lincoln Laboratory, Massachusetts Institute of Technology, announces a major expansion in its program. We urgently request the participation of senior members of the scientific community in our programs in:**

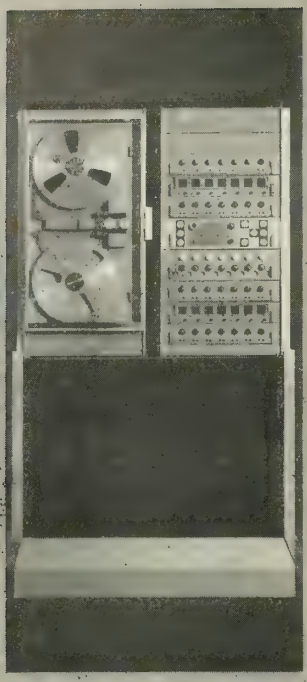
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Through installment purchases, you are investing in your Ampex data recorder while it works for you.

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*Box 5000 Redwood City, California*

# contracts

## NASA

$566,370—**Carl N. Swenson Co., Inc.**, San Jose, Calif., for office and test chamber building for the mass transfer cooling and aerodynamics facility, Ames Research Center.

$86,500—**Space Technology Laboratories, Inc.**, Los Angeles, for investigation of ion beam diagnostics.

$50,400—**Ampex Corp.**, Atlanta, for transistorized magnetic instrument recording center.

## NAVY

$9,500,000—**Interstate Electronics Corp.**, Anaheim, Calif., letter of intent for design, manufacture and test of instrumentation systems for SSBN-616 *Polaris* submarines.

$8,500,000—**Sperry Marine Division of Sperry Rand Corp.** for management, design, manufacture, and installation of navigation equipment on newest *Polaris* submarines. (Two contracts.)

$5,000,000—**Sylvania Electric Products, Inc.**, Waltham, Mass., for communication systems for *Polaris* submarines.

$2,000,000—**ITT Federal Laboratories**, Nutley, N.J., for marine communication and navigation equipment.

## ARMY

$17,260,000—**Systems Division of Bendix Corp.**, Ann Arbor, Mich., for development of communications system for Project *Advent*.

$4,936,812—**Thiokol Chemical Corp.**, Marshall, Tex., for final assembly and loading of missile motors at Longhorn Ordnance Works.

$2,650,720—**Capehart Corp.**, Richmond Hill, N.Y., for R-390(a) radio receivers.

$1,008,889—**Dallas Building, Inc.**, Dallas, for nuclear warfare laboratory at Kirtland AFB, N.M.

$930,822—**Acme Missiles & Construction Corp.**, Rockville Centre, N.Y., for construction of FPS-24 and FPS-26 radar tower facilities at Missile Master, Pittsburgh Defense Area, Oakdale, Pa.

$815,866—**Radioplane Division of Northrop Corp.**, Van Nuys, Calif., for flight services for target missiles.

$500,000—**Space Technology Laboratories, Inc.**, Los Angeles, for systems engineering and technical services on Project *Advent*.

$430,624—**Aeronutronic Division of Ford Motor Co.**, Newport Beach, Calif., for *Nike-Zeus* missile system vulnerability study and technical reports.

$405,346—**Belock Instrument Corp.**, College Point, N.Y., for industrial engineering services in connection with the *Hawk* missile training device 3-G-36.

$378,005—**General Electric Co.**, Philadelphia, for additional services in connection with design, development and fabrication of the *XM-77* adaptation kit.

$280,000—**Ryan Electronics**, for spares for AN/APN-129(V) navigation sets.

$136,401—**Raytheon Co.**, Waltham, Mass., for Doppler video transmitter for *Hawk* missile system.

$126,300—**Keco Industries, Inc.**, Cincinnati, for unit conditioners for *Titan II* missile launch facilities.

$122,866—**Herbert E. Ellis**, Berkeley, Calif., for *Nike-Hercules* conversion, special AAA Site T-86 C&L, Solano Co., Calif.

$97,951—**Haven Cooling Towers, Division of Haven Structural Steel Co.**, Kansas City, Mo., for cooling towers for *Titan II* missile launch facilities.

$95,000—**Rixon Electronics, Inc.**, Silver Spring, Md., for custom-designed Sebit-24, data mode equipment.

$89,434—**Associated Aero Science Lab**, Hawthorne, Calif., for civilian technical assistance for *Jupiter*.

$65,338—**Quinco Electric Co., Inc.**, Orlando, Fla., for instrumentation sites for the *Saturn* rocket complex, Cape Canaveral.

## AIR FORCE

$5,000,000—**Idaho Maryland Industries, Inc.** and **Allied Engineering Co.**, Los Angeles, from **George A. Fuller Co.** and **Del A. Webb Construction Co.**, for miscellaneous *Minuteman* site hardware, Great Falls, Mont.

$3,400,000—**Ryan Aeronautical Co.**, San Diego, for *Q-2C* aerial target drones, spare parts and special support equipment.

$1,800,000—**Ryan Aeronautical Co.'s Aerospace Division**, San Diego, letter contract for *Q-2C Firebees*.

$1,500,000—**Infrared Industries, Inc.**, Riverside, Calif., from **Lockheed's Missiles and Space Division**, for advanced development and production engineering of infrared detectors for the *Midas* system.

$1,470,509—**Kaminer Construction Corp.**, Chamblee, Ga., for fuel storage facility and modification of *Titan II* launchers, Cape Canaveral.

$500,000—**Aerojet-General's Nuclear Propulsion Division**, Azusa, Calif., for nuclear rocket engine research.

$497,050—**General Dynamics/Electronics**, Rochester, N.Y., for engineering, furnishing and installation of ultrahigh-frequency and single-sideband radio communications equipment for command and control functions of missile programs.

$260,000—**Texas Instruments, Inc.**, Dallas, for major components of radar reconnaissance system AN/APQ-86.

$230,000—**North American Aviation**, Los Angeles, for development of rocket catapult.

$200,068—**Electronics Division of Curtiss-Wright Corp.**, E. Paterson, N.J., for spare parts and related data for AN/GPN-T2B radar trainers.

$200,000—**Hycon Manufacturing Co.**, Monrovia, Calif., for design and installation of high-altitude research cameras in *X-15* aircraft.

$150,000—**Intercontinental Electronics Corp.**, Westbury, L.I., N.Y., for design and construction of improved electronic scan converter system.

$100,000—**Hydro-Aire Co.**, Burbank, Calif., for research and development on production of a slurry transfer system.

$89,000—**Radio Corp. of America**, for use of the Moorestown, N.J., test facility for detection and tracking of satellites.

$71,587—**American Optical Co.**, Southbridge, Mass., for a study of optical fiber techniques for data-processing equipment.

**Precision Power Division of American Electronics, Inc.**, Fullerton, Calif., from **The Martin Co.**, Denver, for motor-generator sets for *Titan II* ground support. Amount not disclosed.

# —when and where—

## APRIL

**Seventh Military Operations Research Symposium, ONR, at Boeing Airplane Co.,** Seattle, April 17-19.

**Seventh National Instrument Society of America, Symposium on Instrumental Methods of Analysis,** Shamrock-Hilton Hotel, Houston, April 17-19.

**Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute,** Mark Hopkins Hotel, San Francisco, April 18-20.

**Bureau of Naval Weapons Missiles and Rockets Symposium,** U.S. Naval Ammunition Depot, Concord, Calif., April 18-21.

**American Geophysical Union and American Meteorological Society, Annual Meeting,** National Academy of Sciences, Washington, D.C., April 18-21.

**13th Annual Southwestern Institute of Radio Engineers, Conference and Electronics Show (SWIRECO),** Memorial Auditorium, Dallas, April 19-21.

**American Society of Mechanical Engineers, Metals Engineering Conference, sponsored with American Welding Society,** Pennsylvania Sheraton Hotel, Pittsburgh, April 23-26.

**Symposium on Structural Dynamics of High Speed Flight (confidential), Aerospace Industries Association and Office of Naval Research,** AIA Auditorium, Los Angeles, April 24-26.

**Aerospace Medical Association, Thirty-second annual meeting,** Chicago, April 24-27.

**American Rocket Society, Propellants, Combustion and Liquid Rockets Conference,** Palm Beach Biltmore, Palm Beach, Fla., April 26-28.

**High Temperature Materials Conference, AIME, Cleveland Section,** Pick-Carter Hotel, Cleveland, April 26-27.

**18th Annual Western Section Conference of The Society of the Plastics Industry,** Hotel del Coronado, Coronado, Calif., April 26-28.

**Seventh Region of the Institute of Radio Engineers, 1961 Conference,** Hotel Westward Ho, Phoenix, April 26-28.

**British Interplanetary Society, Symposium on Liquid Hydrogen as a Rocket Propellant,** Royal Aeronautical Society, London, April 28.

## MAY

**Instrument Society of America, Seventh Annual Aerospace Instrumentation Symposium,** Hotel Adolphus, Dallas, April 30-May 4.

**Electric Components Conference, Institute of Radio Engineers, Electronic Industries Association, Western Electronic Manufacturers Association, American Institute of Electrical Engineers,** Jack Tar Hotel, San Francisco, May 2-4.

**ARS/ORNL Nuclear Applications in Space Conference,** Oak Ridge National Laboratory, Gatlinburg, Tenn., May 3-5.




PLEASE DON'T SWALLOW OUR MOTOR

...IT'S HIDING BEHIND THE ASPIRIN. Actually, we set out to build an easy-to-read tiny timer... but we first had to build an aspirin-sized motor to drive it. This assignment might have been a headache for a sorcerer, but A. W. Haydon did it. And there is something magical about these micro-miniature elapsed time indicators and companion events counters. ■ This digital elapsed time indicator has many outstanding features: size is only ½" square x 1 1/16" long... weight .75 ounce...




meets all mil specs... temp. range −54 to +125°C... vibration to 2000 cps at 20 G... choice of two ranges (hours to 9999, tenths to 999.9)... power input .5 watt, max. In fact, the complete data outweighs the equipment. Send for our heavyweight literature on the 19200 ETI right now. ■ Electrical or electronic, the A. W. Haydon Company works wonders in time. For electronic requirements call Culver City. For electromechanical devices call on our wizards in Waterbury.

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**ABC'S OF RADAR**, Alan Andrews. Catalog No. ABR-1. Howard W. Sams & Co., Indianapolis 6, Ind. 112 pp., $1.95.

The book explains the fundamentals of radar in simple and understandable terms. It is designed to provide basic information on transmitter-receiver theory and operation to users of radar and operating and maintenance technicians. Representative radar systems are covered.

Chapters include: How Radar Works; Radar Systems; Microwaves; Microwave Oscillators; Timers and Modulators; Antenna Systems; Radar Receivers; Indicators.

**ANALOG SIMULATION OF A PILOT-CONTROLLED RENDEZVOUS**, Roy F. Brissenden, Bert B. Burton, Edwin C. Foudriat, and James B. Whitten. Order NASA Technical Note D-747 from National Aeronautics and Space Administration, Washington 25, D.C. 51 pp.

A simulator investigation has been made of the controls and instruments required for the rendezvous of a space ferry with an orbiting space station in the presence of various initial conditions and with ranges up to 50 miles.

A human pilot controlled a fixed-base simulator in six degrees of freedom. A single rocket and reaction-attitude controls were assumed.

**A THERMODYNAMIC ANALYSIS OF THRUST AUGMENTATION FOR NUCLEAR ROCKETS**, Hugh M. Henneberry, Lester C. Corrington, and Roger D. Becker. Order NASA Technical Note D-581 from National Aeronautics and Space Administration, Washington 25, D.C. 30 pp.

Thrust augmentation of the nuclear rocket system was obtained by the addition of chemical power. A liquid oxidant, oxygen or fluorine, was added to burn with the heated hydrogen propellant issuing from the reactor.

The specific impulse of the nuclear rocket afterburner was optimized by the addition of liquid hydrogen along with the oxidant. Data are presented for hydrogen reactor exit temperature from 3500° to 6500°R.

Comparison with other chemical thrust augmentation systems described herein indicated that the optimum afterburner is the most efficient method of chemical thrust augmentation for nuclear rockets.

**AN INSTRUMENT TO MEASURE THE SOLAR CONSTANT FROM A SATELLITE**, Rudolf A. Hanel. Order NASA Technical Note D-674 from National Aeronautics and Space Administration, Washington 25, D.C.

Satellites now provide the unique opportunity of measuring the solar constant directly, without interference from the atmosphere. The equilibrium temperature of an ideal black body mounted on, but thermally isolated from, a sun-oriented satellite, is governed by Stefan-Boltzmann's law.

A small hole in a spherical shell closely approaches such an ideal black body. A thermostat adjusts the temperature of the sensor housing close to the expected temperature of about 122°C, and thereby virtually improves the isolation further. A metal bolometer in a bridge circuit senses the temperature of the black body electrically.

**STUDY OF SYSTEMS USING INERTIA WHEELS FOR PRECISE ATTITUDE CONTROL OF A SATELLITE**, John S. White and Q. Marion Hansen. Order NASA Technical Note D-691 from National Aeronautics and Space Administration, Washington 25, D.C.

Various possible inertia wheel systems are examined for suitability for precise satellite attitude control; three of these systems, which appear more promising than the others, are analyzed in detail—using the Orbiting Astronomical Observatory as an example.

Theoretical and experimental investigations show that the system which uses an error-rate network to provide damping is superior to the other two systems. Experimental data taken under laboratory conditions with relatively large extraneous disturbances show that a dynamic tracking error of less than ± 0.5 sec. of arc was obtained.











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# ADVERTISERS' INDEX


Ampex Data Products Co. ..... 50
Agency—Boland Assoc.

Andrew Corp. ..... 46
Agency—Frank C. Nahser, Inc.

Arcturus Mfg. Co. ..... 55
Agency—Anderson-McConnell Adv. Agency, Inc.

Blaw-Knox Co. — Equipment Div. ..... 33
Agency—Ketchum, MacLeod & Grove, Inc.

Boeing Airplane Co. ..... 4
Agency—Fletcher, Richards, Calkins & Holden, Inc.

Bristol Co., The, Aircraft Equipment Div. ..... 47
Agency—Chirurg & Cairns, Inc.

Callery Chemical Co. ..... 32
Agency—Ketchum, MacLeod & Grove, Inc.

Cohu Electronics, Inc.—Kin Tel Div. ..... 19
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Commonwealth of Pennsylvania, Dep't. of Commerce... 53
Agency—Bachman, Kelly & Trautman, Inc.

Defense Systems Div.—General Motors Corp. ..... 41
Agency—D. P. Brother & Co.

Edgerton, Germeshausen & Grier, Inc. ..... 34
Agency—Reach, McClinton & Humphrey, Inc.

Electronic Communications, Inc. 9
Agency—Alfred L. Lino & Assoc.

General Electric Co., Missile & Space Vehicle Dept. ..... 24, 25
Agency—George R. Nelson, Inc.

B. F. Goodrich Aviation Products Co. ..... 30
Agency — The Griswold-Eshleman Co.

Gould-National Batteries, Inc.... 52
Agency—E. T. Holmgren, Inc.

Hallicrafters Co., The ..... 38
Agency—Henry B. Kreer & Co., Inc.

A. W. Haydon Co., The ..... 51
Agency—Hicks & Greist, Inc.

Johns-Manville Corp., Industrial Insulations Div. ..... 8
Agency—Cunningham & Walsh, Inc.

Librascope Div., General Precision, Inc. ..... 2
Agency—Compton Adv., Inc.

Lincoln Laboratory — Massachusetts Institute of Technology ..... 49
Agency—Randolph Assoc., Adv.

Litton Industries, Litton Systems, Inc. ..... 10
Agency—Compton Adv., Inc.

Marquardt Corp., The ..... 6, 7
Agency—Grant Adv., Inc.

McCormick Selph Assoc. ..... 22
Agency—Long Adv., Inc.

Microdot, Inc. ..... 3
Agency—Carson/Roberts/Inc.

Northrop Corp., Nortronics Div. 20
Agency—Doyle, Dane, Bernbach, Inc.

Radio Corp. of America, Defense Electronic Products 28, 29
Agency—Al Paul Lefton Co., Inc.

Rocketdyne, a Div. of North American Aviation, Inc. ..... 42, 43
Agency—Batten, Barton, Durnstine & Osborn, Inc.

Sperry Gyroscope Co., Air Armament Div. ..... 27
Agency—Reach, McClinton & Co., Inc.

System Development Corp. ..... 12
Agency—Fuller & Smith & Ross, Inc.

Thiokol Chemical Corp., Rocket Div. ..... 36, 37
Agency—Hicks & Greist, Inc.

Varian Assoc., Radiation Div.... 56
Agency—Hoefer, Dieterich, & Brown, Inc.

Vitro Electronics, a Div. of Vitro Corp. of America ..... 45
Agency—Sam J. Gallay, Adv.


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## editorial . . .

# Yield Not to Political Temptation

TOURING the missile/space industry in California these days is a lot like studying a can of worms. There's an awful lot of wiggling but not very much agreement on where everyone is going.

The president of one electronics firm will tell you business is good, costs are well in hand and profit margins are favorable. Another says things couldn't be worse. It depends a lot on whom you ask.

But one major question is voiced by almost every company executive you talk to in California. It is the same for both large and small firms. The question is this: Is the Kennedy Administration going to exact revenge on Richard M. Nixon's home state by diverting defense contracts elsewhere?

Politically, it would not be surprising. Nationally, it would be foolish, uneconomic and potentially dangerous. Let us hope the Kennedy Administration can rise above the natural temptation.

On this page last week, we argued the need for award of contracts on merit—not on the basis of depressed economic areas. The same reasoning applies in this case. Contracts must be awarded on merit—not geography.

Largely due to a favorable climate and accessibility of desert and sea test areas, California became the center of the U.S. aircraft industry before and during World War II. A large industrial labor pool was built up around that industry.

In the postwar period, a booming electronics industry dug its roots deep into both northern and southern California. Conditions for light industry were favorable and the sunshine looked great in the recruiting ads.

When the missile/space industry was born, many of the skills and techniques required were to be found in the two older industries, aircraft and electronics. It was natural that as the new industry evolved, it should be heavily concentrated in the same area.

Once again, climate and terrain played an important role. The Air Force found a hilly site for a rocket test base only a few miles across the dry lake from its Edwards Air Force Base Flight Test Center. Desert isolation made it easier to protect flights of the *X-10* and other early missiles from a security standpoint.

Aerojet-General found the non-arable land for its big rocket test site in the rocky gold fields near Sacramento. The Santa Susana mountains enabled Rocketdyne to carry out test firings on the very edge of Los Angeles. Lockheed bought thousands of acres on the northern California coast near Santa Cruz for a test base; United Technology last week dedicated its new test and development center on a 3200-acre site in the mountains near Morgan Hill, only 70 miles south of San Francisco.

In each case, these bases are within easy reach of the cities and industrial complexes needed to support them. Major universities are at hand to provide scientific backup.

All of these factors have combined to make California one of the most important centers in the missile/space industry. In spite of this, California dominates the missile/space industry far less than it did the aircraft industry.

New skills, new techniques were needed in the missile/space industry and many of them were to be found elsewhere. Top names in our industry today include many which were not active in airframe manufacture: General Electric, Western Electric, Westinghouse, RCA, IT&T, Raytheon, Bendix and others. The missile/space industry is spread far more evenly from a geographic standpoint than the aircraft industry was. Eastern firms play a much larger role.

Congressional representatives of other states, particularly New York, have been quick to sense California's political vulnerability. Its position as Nixon's home state, and as one which was in the Republican column in the presidential election, makes it an easy target. The overt attack is on other grounds, but this is the basis for it.

NEW YORK ARGUES against an over-concentration of defense contracts in California. Yet of the top ten firms in net value of military prime contracts in Fiscal 1960, only three are based in California; four are based in New York.

Of the top 25 firms on the list, only seven are in California.

This editorial is not in any way an argument for award of contracts in California, simply because it is California. A Western location as such is no more recommendation than an Eastern location. Merit must be the yardstick.

But one of the uncomfortable facts of life for the Californians is that any open and organized effort to fight the situation may only make it worse. How to fight a battle on political grounds which have not been acknowledged is a ticklish problem. Unscrupulous exploitation of the situation could do real harm to the nation's missile/space capabilities.

We urge the administration to put national interest above political interest. Geographic location must not for any reason be a determining factor in contract awards.

**William J. Coughlin**



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Men have searched the sky for knowledge since history began. Each generation sees farther, learns more. But the human eye is reaching its limit—and there is still much more to know.

Radar astronomy can help. In Puerto Rico, the world's largest radar will send beams from an unusually powerful transmitter into a 1,000-foot wire mesh reflector, to bounce back out into space. The returning signals will extend man's "vision" by millions of miles.

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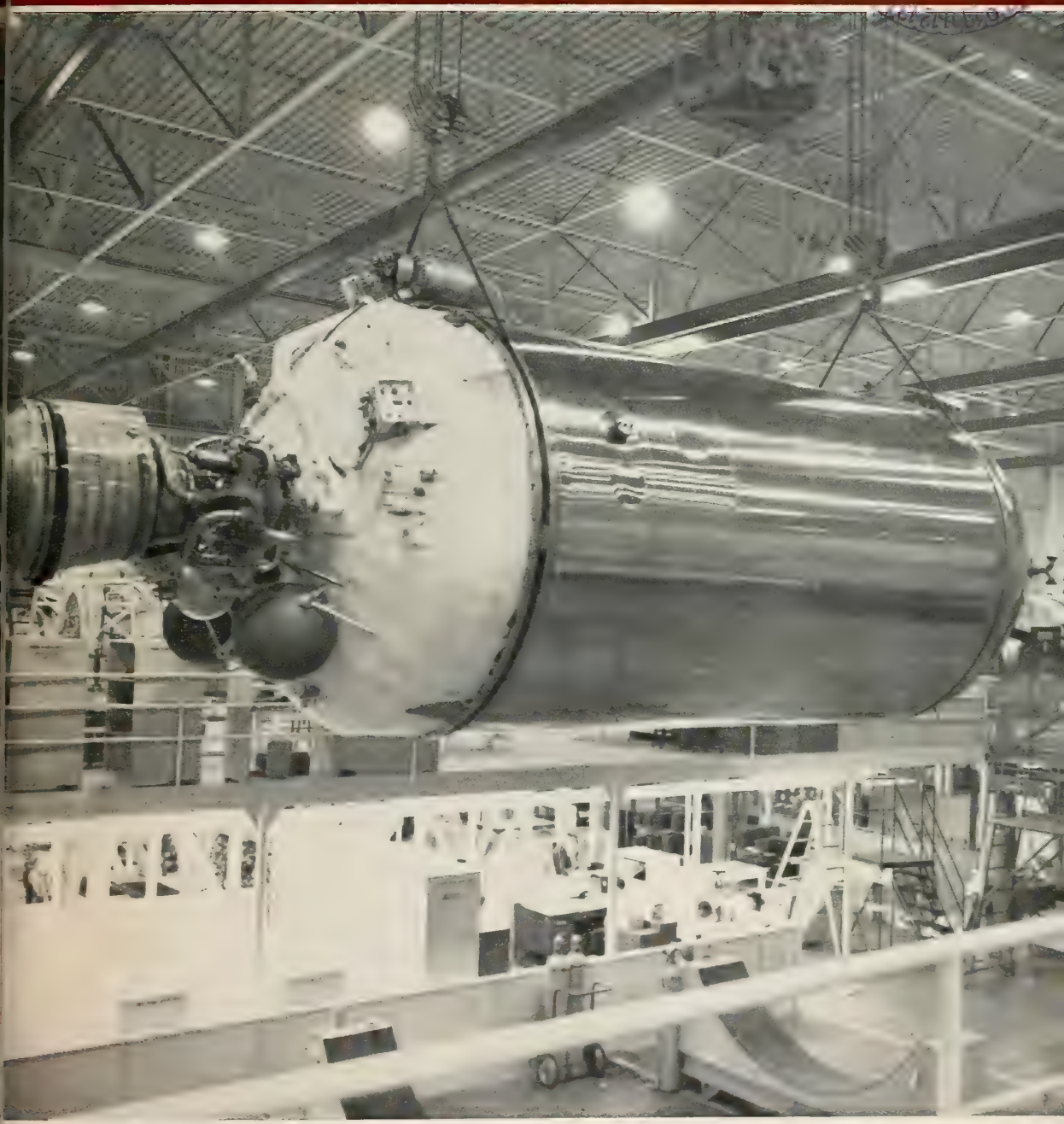
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# missiles and rockets

THE MISSILE/SPACE WEEKLY

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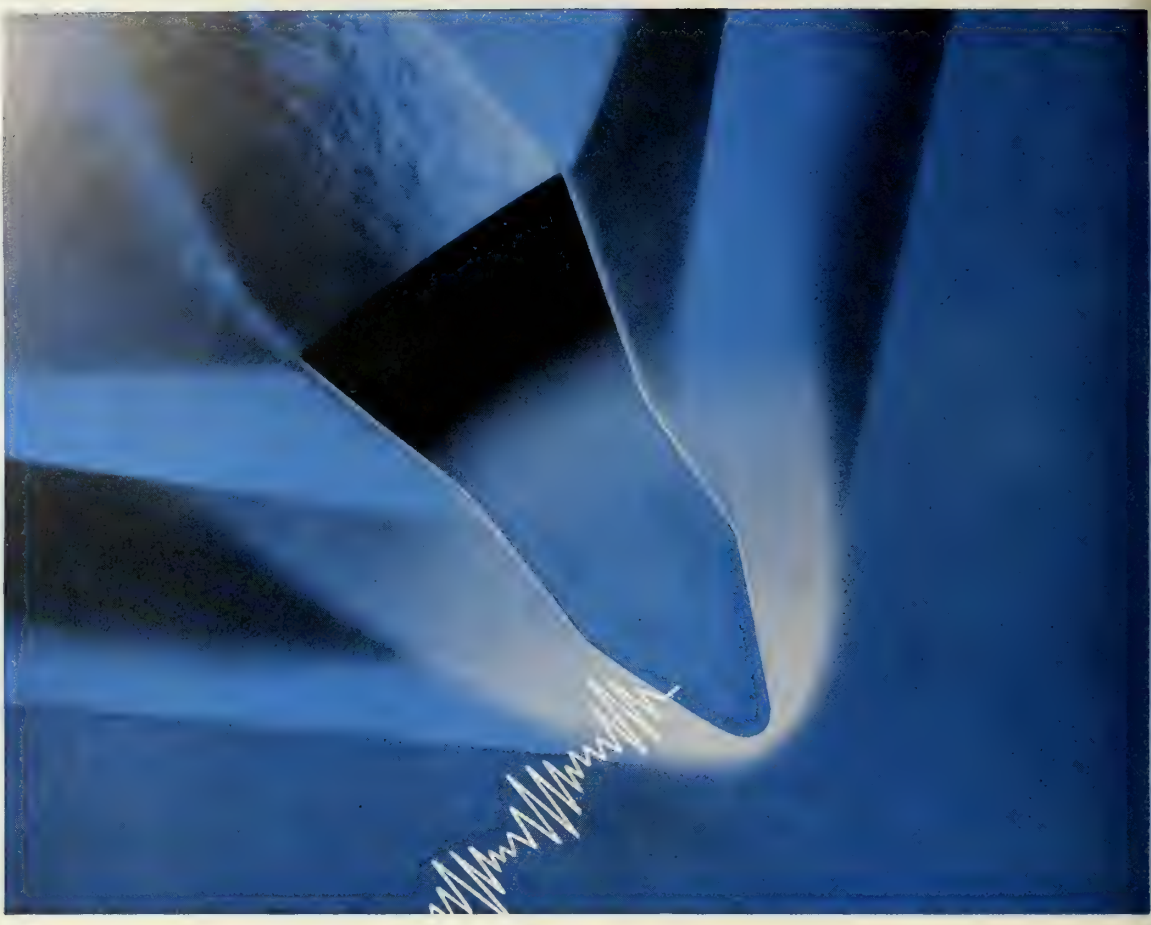
*Centaur Heads for Static Testing*

## CAMAL Knocked from AF's Arsenal . .

## Drydocks Proposed as Launch Platform

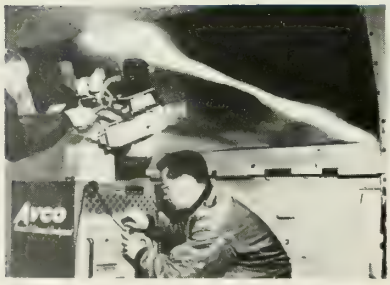
## Direct Winding May Cut Cost of Cases

ON



## Piercing the plasma sheath...

When ICBMs, satellites or space probes re-enter the earth's atmosphere, frictional heating is so intense that air surrounding the vehicle becomes a "plasma sheath." This acts as a barrier to conventional radio telemetry. AVCO/RAD has developed a Direct Re-entry Telemetry (DRET) system for the U. S. Air Force. The DRET system has been flown on Atlas and Titan ICBMs and has successfully transmitted signals to airborne monitoring equipment. Engineers and scientists at AVCO/RAD are also working on techniques for continuous communications with re-entering manned vehicles, as well as on other conditions in which a plasma barrier exists and where signal penetration is required.

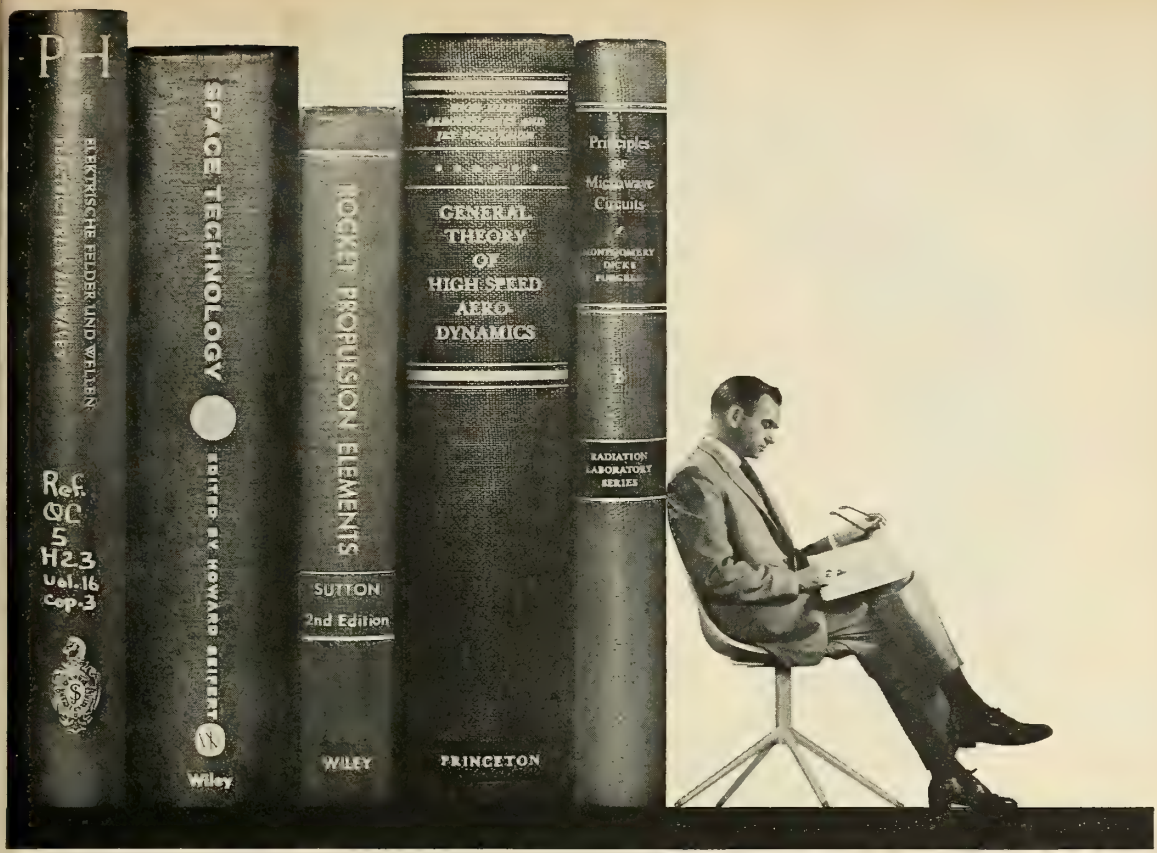



Airborne re-entry tracking team of Avco's RAD Division monitor an Avco Mark 4 re-entry vehicle launched by Titan ICBM.

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**Said J. Stefan and L. Boltzmann:** *"The total radiation from a black body is proportional to the fourth power of the absolute temperature of the black body."*

Radiation is usually associated with high temperatures. Yet very cold bodies emit a radiation which can be highly significant in missile and space applications. The problem faced by infrared scientists, trying to detect variations in radiation from low temperature atmospheres, can be likened to detecting a one-foot cube of ice from a distance of five miles.

Lockheed Missiles and Space Division scientists are deeply engaged in studying the problems of infrared emission from the earth and its atmosphere, as seen from orbital altitudes. Although the earth resembles a black body at 300° Kelvin, the emission from its atmosphere, under some circumstances, is much colder. To make measurements under these circumstances, Lockheed has evolved radiometric equipment with one of the most sensitive detection systems yet conceived.

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THE MISSILE / SPACE WEEKLY

# missiles and rockets

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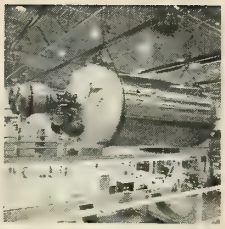
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## THE COVER

*NASA's first Centaur spacecraft test vehicle is hoisted from dock at Convair's San Diego plant en route to static testing at nearby Sycamore Canyon.*

## APRIL 24 HEADLINES

ANP Decision Knocks CAMAL from Air Force Arsenal..... 14
U.S. Seriously Considers Man-on-Moon Crash Program... 16
Explorer X Proves Existence of Solar Wind..... 17
Latex Designs Highly Flexible AF Space Suit..... 18
Canada Making Long-legged Satellite for NASA Shot..... 18
NASA Gives Go-ahead to UTC's 3-Segmented Motor..... 21

## ELECTRONICS

NBS Plans to Use Extra Funds to Study Propagation..... 25

## SEA LAUNCHING

Flexibility Behind Drydock Platform Proposals..... 26

## PROPULSION ENGINEERING*

Direct Winding May Cut Solid Motor Case Costs..... 30
Data Is Lacking to Solve Combustion Problems..... 32

## SPECIAL REPORT

Soviet 'Super Agency' to Exploit Space Advantage..... 34

## ADVANCED MATERIALS†

Adhesive Takes High Temperature and Thermal Shock..... 40

## INTERNATIONAL

British Outline Wide Range of Space Research Work..... 41

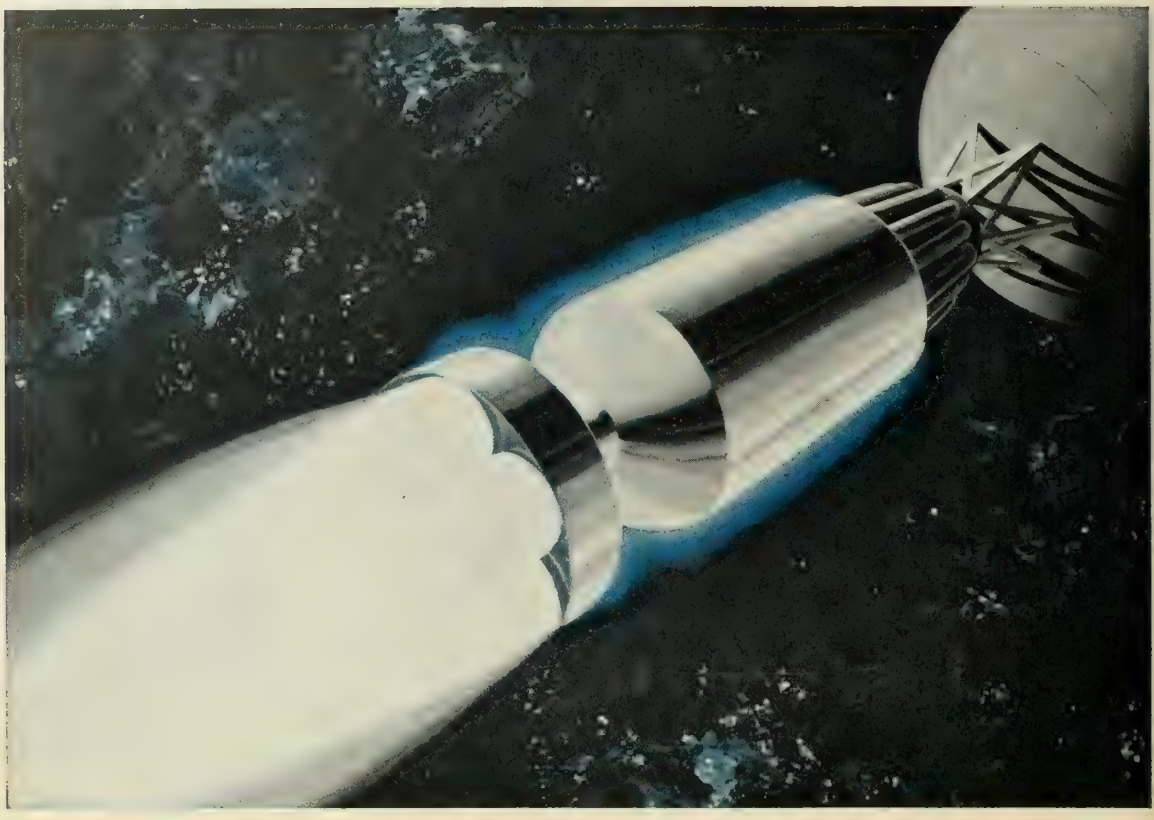
## DEPARTMENTS

The Countdown ..... 7
The Missile/Space Week† ..... 9
Technical Countdown ..... 23
Contracts ..... 47
Names in the News ..... 49
Products & Processes ..... 50
Letters ..... 52
When and Where ..... 53
Editorial ..... 54

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# NUCLEAR ROCKET PROPULSION AT AEROJET-GENERAL



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# The Countdown

## WASHINGTON

### Is Saturn Already Outclassed?

*Saturn*—billed as the white hope of the nation's lagging space program—already appears to have been dwarfed by the Soviets. COUNTDOWN is told that a high-level analysis of the manned orbital flight April 12 indicates strongly that the total weight placed in orbit was between 25,000 and 30,000 lbs. This is 25 to 50% more than the *Saturn C-1* will be able to loft into orbit in its first scheduled flights in 1964. With such a capability now, the Russians could have boosters in the multimillion-pound-thrust *Nova* class by 1964—making the "Booster Gap" even wider.

### A Military Wedge for Space Dollars

The secret Gardner Report on the military uses of space is expected to be used by the Air Force as a powerful wedge for obtaining more money for military spacecraft in the FY '62 budget. At present, the Kennedy defense budget contains no significant funding for such offensive and defensive military spacecraft as have been advocated by Air Force officials.

### Titan I and Titan II Coming Up

The Air Force now is planning its first *Titan I* launching from a silo in May. The launching was delayed by an unexplained explosion in the *Titan* test silo at Vandenberg AFB last year. The first *Titan II* launching is now scheduled at Cape Canaveral in November.

### Eagle Re-examined

The Navy is trying to decide whether it should make another fight to revive the *Eagle* air-to-air missile or give the program a permanent burial. One key question: Can *Eagle* be usefully employed with existing aircraft?

### Pentagon Direct Line

Offsetting rather mild complaints that the new National Aeronautic and Space Council is heavily represented on the civilian side, Council Executive Secretary Edward Welsh is letting it be known that he already is establishing direct liaison with the R&D chiefs of the Army, Navy and Air Force. Welsh says the council staff wants to be informed of all impending major decisions affecting space before they reach the Secretary level.

### Samos Fadeout

Next step in the Kennedy Administration's campaign to hush up all information about the *Samos* TV reconnaissance satellite program probably will be to drop a secrecy cloak on all future launchings from PMR's Pt. Arguello. Information from the first R&D *Samos* is understood to be of higher quality than that obtained in U-2 overflights.

### End of a Committee

The famed Von Neuman Committee which gave the country the great push that launched the first crash programs to develop ICBM's is no more. The Pentagon has dropped the Ballistic Missile Advisory Committee, as it had come to be called. However, some of its members will be retained as consultants. The move was in line with the Administration drive to reduce the number of government committees.

## INDUSTRY

### Joshua ICBM Program Under Way

A $100,000 contract to Marquardt confirms the existence of a secret Air Force project aimed at eventual development of a lightweight ICBM. Work on the program—known as *Joshua*—is under way at Edwards AFB Rocket Test Agency. Marquardt will design and fabricate fuel injectors for full and sub-scale testing.

### Army To Buy Drop-Boost Test Missiles

The Army is expected soon to award a contract to Convair-Ft. Worth for nine drop boost missiles to be used in a test program for the *Pershing*. The solid-propellant missiles will be dropped from an aircraft, then accelerated to the impact speed of the *Pershing* to test components.

### R&D Intelligence

Qualification test firings with practice versions of the nuclear-tipped *Falcon* GAR 11 will be held this summer at Tyndall AFB, Fla., to determine whether it will be bought by NORAD for F-102 interceptors. . . . B.F. Goodrich Aviation Products has a new solid propellant—C-123—composed of Nitro C-Rubber and Hycar synthetic rubber mixed with high-energy compounds. Company claims C-123 has a 15 lb./sec increase in specific impulse over present rubber-based fuels, as well as being lighter in weight.

### More Army and Navy Missile Money

Kennedy add-ons to the FY '62 defense budget include $25.3 million for developing a new armored recon/assault vehicle to carry *Shillelagh* and $28.4 million to speed development of the *Mauler* tactical air defense missile. . . . *Polaris* will receive $123.4 million of the $133.4 million added to Navy missile procurement. The remaining $10 million goes into buying 1000 *Bullpups*.

### Thought of the Week

From Avco Vice President C. S. Irvine: "I am fully convinced that in 1970, the world will be heading toward all-out democracy and all that it stands for—or it will be going down the road of enslavement and communism."

## INTERNATIONAL

### Water on the Moon?

British astronomer Zdenek Kopal is reviving the idea that astronauts may find water on the moon—perhaps in subsurface glaciers. Kopal believes upheavals from ice might be the reason for "domes" observed in large numbers in the lunar crust.

### Overseas Pipeline

Chancellor Adenauer is now saying that Germany is forbidden to build rockets under the World War II surrender terms—apparently in explanation for holding up the joint European Space Launcher plan. . . . First meeting for the European Preparatory Commission for Space Research (COPERS) will take place May 16 at The Hague. . . . Why some people read *Pravda:* In the March 26, 1961, issue (17 days before Yuri Gagarin's flight) Soviet Academician N. Sisakyan is quoted as saying "tremendous amounts of experimental data" have been obtained which testify to the possibility of manned space flight "right now."



## MACE CAPABILITIES AND ACCURACY—A TOUGH INERTIAL GUIDANCE JOB ACHIEVED BY AC!

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## An Orbital MA-3 Shot?

In an obvious reaction to the Soviet manned orbital flight, an orbital *Mercury* capsule flight is under consideration for the third *Mercury Atlas* launching *(MA-3)*.

The *MA-3* flight may take place this week. The National Aeronautics and Space Administration will decide a short time before launching whether to make the trajectory a single orbit or immediate re-entry after orbital injection.

Meanwhile, plans are going ahead for the manned *Redstone* flight *(MR-3)*, which will take place soon after *Little Joe 7*, scheduled from Wallops Island, Va., last weekend.

The tentative plans are for one *Mercury* flight from Cape Canaveral this week. If the *MA-3* is flown as planned this week, *MR-3* will lay over until the week of May 1.

However, if there is delay for any reason on *MA-3*, the manned *Redstone* launch is to take place on the previously scheduled date of April 28.

All of the immediate *Mercury* launch plans depend somewhat on the success of *Little Joe 7*, a final qualification of the *Mercury* escape system.

The new *Little Joe* was to be largely a repeat of the *Little Joe 6* flight March 18, using the same capsule after repairs at the McDonnell Aircraft plant.

However, the capsule landing bag was not attached because air-drop tests have qualified it sufficiently.

The previous *Little Joe* failed to test the escape system under maximum air loading because the escape rocket fired prematurely. Wiring changes were made for greater assurance that the maneuver will take place on time.

The *Little Joe* was programed to burn out in about 30 sec., with the escape sequence scheduled for 3 sec. later at about 35,000 ft.

The escape tower was to be jettisoned about 1 min. after launch at the peak altitude of 45,000 ft.—about 6 miles offshore.

Escape maneuver involves four steps: (1) separation of capsule from vehicle, (2) firing of the 60,000-lb.-thrust escape rocket, (3) separation of the burned-out escape rocket and tower from the capsule and (4) deploying parachutes.



### Multiple-Launching Maces

*MACE "A" TACTICAL MISSILE takes off as three sister birds await immediate follow-up firing. The system, being set up for the Air Force in Europe, will fire four of the Martin missiles in less time than it has taken to fire one.* *See p. 10.*

## Shots of the Week:

At Eglin AFB: Three Air Force *Bomarc B* missiles sped to targets over the Gulf of Mexico and scored two out of three hits. One intercepted and destroyed a *Regulus* target missile launched from down the coast. The second, aimed at a RB47 drone bomber, malfunctioned and dropped into the sea. The third shot downed a target flying at 35,000 feet, 230 miles from its launch site.

At Wallops Island: A bright orange sodium cloud was emitted from a NASA *Nike-Asp* rocket to study high-altitude wind patterns. The test was made in conjunction with similar tests at the Island of Sardinia by the Italian Research Committee.

On March 14, an *Aerobee* research rocket failed after 52 seconds of flight when one of its solenoid-operated cold gas valves malfunctioned.

## Saturn Hardware Run

The *Saturn* barge Palaemon is wending its way to Cape Canaveral from Huntsville on a trial run.

Two pieces of *Saturn* hardware—a booster weight simulator and an inert third stage—are on the 1200-ton vessel. The third stage will be left at the Cape for the first *Saturn* launch later this year.

Objectives of the trial are to check out the stage loading and unloading techniques, environmental control and observe the stresses to which the rocket units will be subjected.

## B-70 Cut Defended Again

Defense Secretary Robert S. McNamara again backed up the decision made by President Kennedy to cut the B-70 program.

McNamara told a Senate Appropriations committee that the B-70 was cut because it couldn't carry the latest *Hound Dog* or *Skybolt* missiles, it would fly only at subsonic speed in low-altitude attack and "does not lend itself to airborne alert measures."

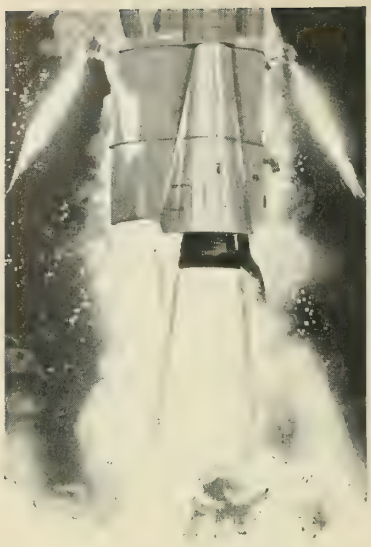
He added that cancellation had been considered, but that since $800 million had already been invested in the program it was considered more beneficial to add another $500 million. Some $220 million has been budgeted for the next fiscal year.

## DOD Defends Contractors

The Department of Defense "took up" for its contractors last week and said it opposed setting an overall patent policy which would require taking title to all inventions perfected under a federal contract.

Such a policy would seriously disrupt military R&D programs, G. C.

*(Continued on page 10)*



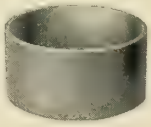
# R/M ASBESTOS-PHENOLICS

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R/M asbestos-phenolic parts are used on virtually every U.S. missile. They exhibit a highly desirable combination of properties such as low thermal conductivity and diffusivity, low rate of ablation, high strength-to-weight ratio, excellent shock resistance and structural integrity.

Asbestos-phenolic felts, mats and molding compounds are available for prompt shipment from R/M in production quantities. And they are backed by comprehensive technical data and know-how. Write for information and engineering help.



Tape wound rocket motor tube liner of R/M Style 41RPD Pyrotex.®

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Reinforced Plastics Department, Manheim, Pa.

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

## Missile/Space Week

*(Continued from page 9)*

Bannerman, Deputy Assistant Defense Secretary for procurement, told a Senate subcommittee. Since DOD selects the researcher most advanced in his field, such a policy would make him lose the very commercial advantage which led him to start in the field in the first place. And the defense effort would suffer since advanced work being done in commercial laboratories and design departments would no longer be offered to DOD.

Two bills are pending in the Senate which would reserve to the government titles of all inventions underwritten by public contracts.

### Salvoes of Maces

The Martin Co. is installing a new rapid-fire multiple launch system for *Mace* missiles at bases in Europe.

The system, developed by Martin with Goodyear Aircraft Corp., will allow all *Mace "A"* missiles to be fired in salvoes, and cut down the number of crew members required. Countdown for four missiles can be held almost simultaneously under the new operation.

The tactical missile can use either nuclear or conventional warheads.

### BAMBI Studies Pressed

Two study contracts valued at about $3 million each have been awarded by the Air Force to investigate the BAMBI concept of ballistic missile defense. Convair and Space Technology Laboratories were recipients.

The studies involve development of a system for orbiting a number of defense satellites. Convair recently finished another study on a space-based missile defense called SPAD.

### Adding Pad at Arguello

The Point Arguello Navy missile facility will build a multi-purpose launch pad for high-altitude research rockets.

The pad will be able to handle vehicles with up to 150,000 lbs. thrust. The Navy said it decided to centralize launch operations to save costs because of the increasing number of small rocket launches from the point.

The contract will be awarded about mid-May when bids are opened.



**Checking Deadly Genies**

*AF PILOT makes required preflight inspection of nuclear-tipped Douglas Genie air-to-air rockets on F-101B Voodoo jet fighter. Genie has been operational with Air Defense Command since 1957.*

### Near-Perfect Recovery

A reliability of .99985 in the Project *Mercury* capsule recovery system was achieved during an 18-month test program.

Tests included some 83 operations, both flights and drops of the capsule over the Salton Sea near Westmoreland, Calif.

The full-scale engineering models of the capsule were launched from a C-130 transport at 30,000 feet and successfully landed by Radioplane's ringsail-type parachute at a rate of 30 fps. Radioplane's system also was proven in *Little Joe, Big Joe* and *Atlas* firings.

### Webb Now Stockless

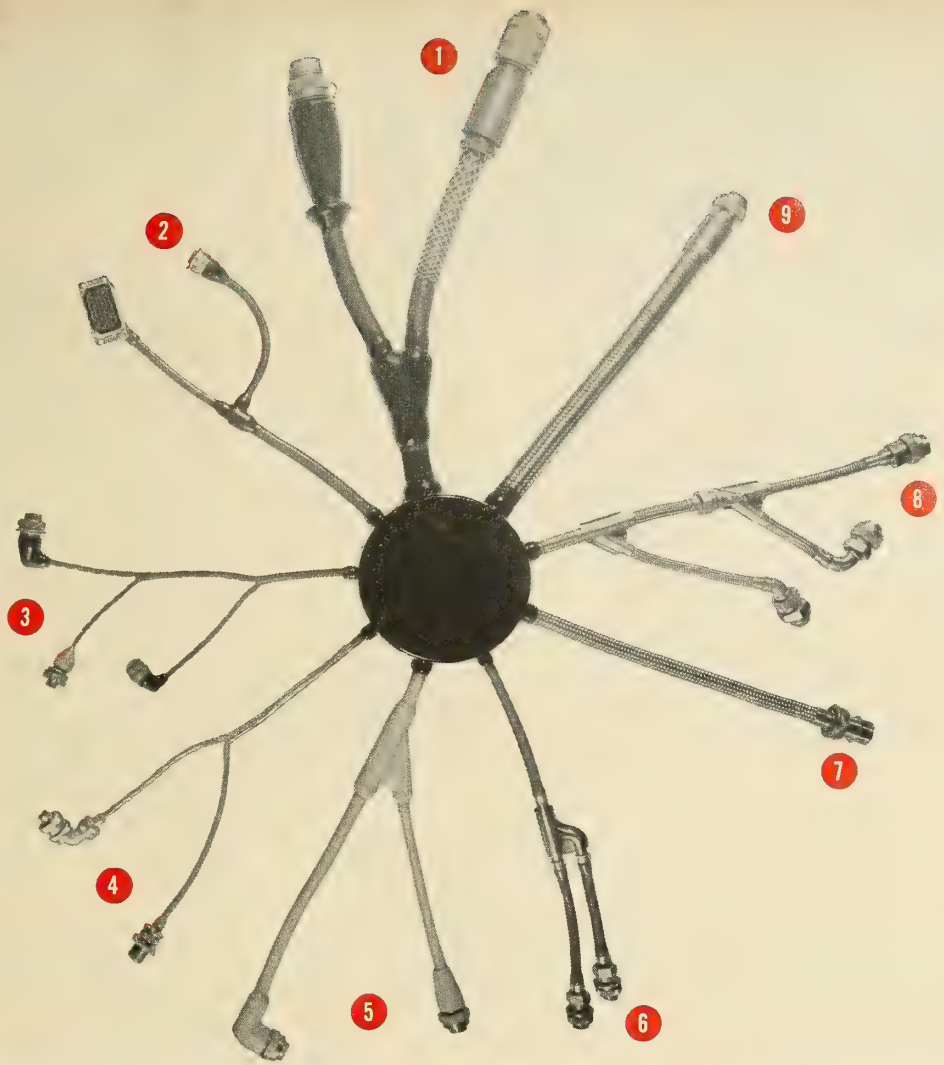
NASA Administrator James E. Webb sold 2248 shares of McDonnell Aircraft common stock during March, reducing his holdings to zero, the Securities and Exchange Commission reported.

### Party for Von Karman

Dr. Theodore von Karman, free world's senior statesman of the aerospace sciences, will be honored on his 80th birthday by a symposium sponsored by the Air Force Office of Scientific Research.

More than 37 organizations,

*(Continued on page 12)*




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2 Benseal® Missile Control Cable
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Useful radiation is efficiently collected by first surface reflectors and concentrated at the reimaging point from where it can be projected by a quartz objective system in a pattern shaped to fit the work area. This carbon arc is adequate in all spectral regions.

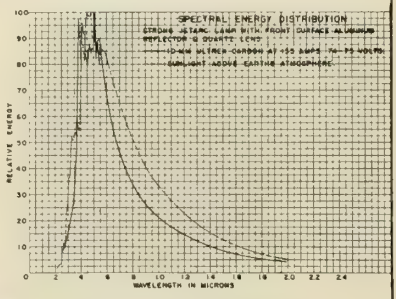
## SUPPLEMENTARY SOURCES NOT NEEDED

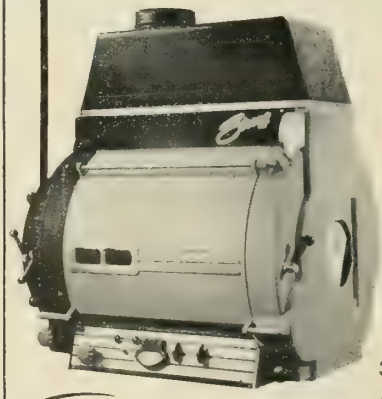
A circular radiation pattern totals 374 watts with an 80% uniformity of field or a total of 668 watts with a 60% uniformity of field. Higher or lower energy unit areas, can be obtained by variation in optics or projection distance. Large areas can be covered by multiple employment of lamps using either superimposed or overlapping pattern technique.

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## Missile/Space Week

*(Continued from page 10)*

headed by the Institute of the Aerospace Sciences, are cooperating in the event to be held May 11 in Washington, D.C.

Dr. von Karman is chairman of the Advisory Group for Aeronautical Research and Development (AGARD) of NATO and honorary president of the International Council of the Aeronautical Sciences.

### Helium Money Cut Back

The House Appropriations Committee has slashed $25 million a year from the maximum amount the Interior Dept. can spend for helium conservation. The gas is used in low-temperature research studies and to force propellants from fuel tanks into rocket engines.

### AT&T Pushes TV Plans

Commercial transatlantic telephone and television is possible within three to four years, the American Telephone & Telegraph Co. has said.

AT&T has asked the FCC for permission to fire an initial experimental satellite within a year.

The company has begun construction on an experimental space communications ground station in western Maine. Bell Telephone Laboratories will set up a huge rotating antenna, 177 feet long and 94 feet high, to beam signals to the satellite.

### Chamber Hits Stoppages

Labor unions averaged one work stoppage every two days at 21 missile bases under construction during the eight-month period ending last February, the U. S. Chamber of Commerce reported.

The Chamber recommended that Congress deny the unions' request to loosen Taft-Hartley law provisions against secondary boycotts.

### Correction

*The Thiokol Chemical Corp. bid on the NASA-AEC Nerva nuclear engine was filed by the company's Nuclear Development center at Parsippany, N.J. M/R reported erroneously on April 10 that the bid was filed by Thiokol's Reaction Motors Division.*



# 200 miles down the Atlantic Range, General Electric silicone rubber will help keep him afloat

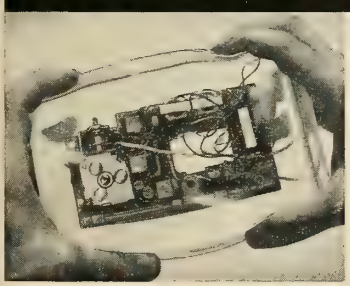


Sixteen and a half minutes after its first manned launching, NASA's blunt-nosed Mercury spacecraft will paradrop into the Atlantic Ocean.

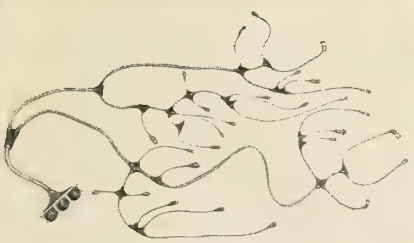
Here it will float like a buoy marker to await recovery. To help protect the first American astronaut, the Mercury spacecraft is completely sealed with General Electric RTV silicone rubber — the new liquid rubber designed to keep the spacecraft air and water tight even after being subjected to the temperature extremes encountered during take-off, flight and re-entry.

McDonnell Aircraft Corporation, prime contractor for the Mercury spacecraft, applies RTV around rivets and bolts wherever structural material, requiring sealing, overlaps or butts together. Able to cure at room temperature, versatile General Electric RTV silicone rubber has found a wide range of uses in missiles and ground support equipment.

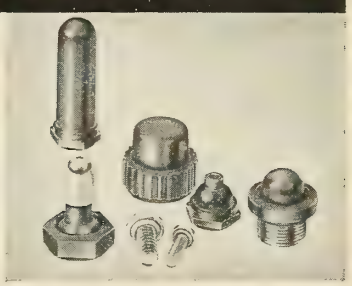
## G-E SILICONE RUBBER FINDS MANY USES IN MISSILES AND SPACE VEHICLES



**Potting and encapsulating materials** protect delicate electronic parts. Clear LTV, shown above, is transparent even in sections several inches thick. RTV liquid silicone rubber encapsulants and clear LTV all exhibit excellent electrical properties, resist shock, vibration, ozone, plus corona and other environmental hazards.



**Missile wiring harness,** above, is from the Titan propulsion system. G-E silicone rubber wire insulation maintains good electrical properties over wide temperature extremes. Jacketing of high-strength silicone rubber, plus breakouts and junctions molded from RTV were chosen for their insulating properties, resistance to temperature extremes and stability in storage.



**Silicone rubber gaskets and seals** give long life, heat resistance, and low temperature flexibility in many missiles and space vehicles. Applications range from nose cone gaskets to tiny Seelskrews and Hexseals, by Automatic and Precision Mfg. Company, which combine fasteners with silicone rubber seals for easy assembly.

For full information on General Electric RTV silicone rubber, clear LTV silicone compound, and fabricated silicone rubber parts, write: General Electric Company, Silicone Products Dept., Section 0444, Waterford, New York.

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# ANP Decision Knocks CAMAL fron

***Kennedy and McNamara argue that plane would have no military value, but apparently have no plans for a strategic substitute***

THE AIR FORCE is being forced to revamp its Missile Age strategic planning by the Kennedy Administration decision to kill development of a nuclear-powered aircraft.

The most significant and far-reaching result of the Kennedy decision is the removal from the Air Force's future arsenal of the most mobile and versatile missile carrier of the 1960's—the so-called CAMAL bomber.

Despite Defense Secretary Robert McNamara's protestation that there is "no specific military requirement" for a nuclear-powered aircraft, many Air Force strategists for years have regarded such planes—loaded with *Skybolts*—as:

—A highly invulnerable missile carrier that could be placed on patrol somewhere in the sky around the perimeter of the Soviet Union, but beyond the reach of the Soviet defenses like *Polaris* submarines on patrol in the sea.

—A low-level penetration bomber that could be employed after the initial strikes of a nuclear war for vital reconnaissance and for seeking out and destroying surviving forces with bombs or air-launched missiles.

Together these capabilities made up the Air Force concept of the CAMAL—the continuously airborne missile launcher and low-level penetration bomber system.

In killing CAMAL, the Kennedy Administration appears to have made no provision for performing these missions in the 1960's.

• **"No military value"**—The President gave as his reason for killing the nuclear-powered aircraft program that "nearly 15 years and about $1 billion have been devoted to (it), but the possibility of achieving a militarily useful aircraft in the foreseeable future is still very remote."

McNamara complained that neither of the two types of nuclear-powered aircraft engines under development "holds any great promise as a practical propulsion unit in the foreseeable future." He said all nuclear-powered aircraft would be very large—"gross take-off weight and landing weight would be in the order of a half million pounds at least." He also added:

"While it is true that with an even larger effort some kind of nuclear-powered flight could have been accomplished by now, the aircraft involved would have had little or no military value. It would almost inevitably have been subsonic and limited to an altitude of 35,000 feet."

Neither Kennedy nor McNamara mentioned CAMAL.

Much of this is difficult to reconcile either with what is known of the current program or with recent history.

The nuclear-powered aircraft program has been plagued for years with a series of stoppages, changes and revisions of requirements and specifications.

Some officials have insisted that a nuclear-powered aircraft would be useless unless it were supersonic. Others have argued that the important thing was to get any kind of nuclear aircraft quickly.

Between these two points have stood the Air Force strategists who have called for a relatively fast CAMAL bomber at earliest possible date.

The nuclear-powered aircraft program which Kennedy killed was designed to meet criteria laid down in the late 1950's. At that time the Air Force was told by the Defense Department to develop a nuclear plane capable of flying at a speed of about Mach .8 at about a 35,000-foot ceiling. Its nuclear core was to have a life of about 1000 hours. The plane would have a gross weight of about 500,000 pounds—not, as McNamara implied, a startling amount but about the gross weight of a new B-52. The plane's airframe, known as NX-2, was being built by Convair. First flights were scheduled for 1965.

Such a plane would be very acceptable to the advocates of the CAMAL bomber. A force of CAMAL's could have been deployed in the late 1960's. Moreover, by then the bomber would have been made much more effective by the expected extension in the 1000-mile range of *Skybolt*.

Therefore, Kennedy and McNamara were criticizing the nuclear plane under development for being what it was designed to be. Nor did they bother to mention in their public remarks precisely what that was.

The new Kennedy defense budget vests the nation's nuclear deterrent power in the second half of the 1960's in the fixed *Atlas*, *Titan* and *Minuteman* bases, the mobile *Polaris* submarines and the mobile *Skybolt* launched from B-52 jet bombers.

But all of these systems with the exception of *Skybolt* bombers have a common failing: They must attack preplanned targets. Otherwise, they are shooting blindly.

Only the *Skybolt* bombers can perform the necessary reconnaissance to determine what enemy targets were missed or seek out mobile enemy targets. However, this boon would be short-lived.

In the first place, only B-52's that were on air or ground alert would have any reasonable chance of survival. Secondly, expiration of airborne refueling could be expected to ground all or almost all of them within 12 to 36 hours.

By then, any U.S. reconnaissance satellites in their predictable orbits would certainly have been destroyed. Tactical bombers would be smashed or grounded for lack of fuel. For the most part, U.S. surviving strategic forces would be fighting with little or no re-

## Cost Alternatives

The cost of completing development of a nuclear-powered aircraft would depend on whether work were continued on both the Pratt & Whitney indirect-cycle engine and the GE direct-cycle engine or a choice were made.

Here is how the cost is estimated in both cases:

**FY '51 to present**

**$508 million** (Air Force)
**$472 million** (AEC)

**$980 million** (Total to present)

***$690 million** (AEC and Air Force—one engine through FY '67 including two years of flight tests)*

***$1270 million** (AEC and Air Force—both engines through FY '67 including two years of flight tests)*

# AF Arsenal

**by James Baar**

connaissance at all. They would be fighting blind.

Both President Kennedy and McNamara, in chopping off CAMAL and sharply cutting back the B-70 Mach 3 bomber which many considered a partly acceptable substitute, indirectly conceded there may be a need for something to take CAMAL's place.

• **Unhappy dilemma**—Kennedy told Congress in his defense message: "We should also explore the possibility of developing a manned bomber system specifically designed to operate in an environment in which both sides have large ICBM forces."

McNamara said a week later: "We plan to explore the possibility of developing other manned systems better adapted to an operational environment in which both sides have large ICBM forces."

However, so far the modestly-funded *Dyna-Soar* and the possibility of manned spacecraft developing from it is the only new manned system with a current R&D program of any size. Nor has the Kennedy Administration so far shown much inclination to accelerate *Dyna-Soar* or other advanced aerospace systems being proposed by the Air Force.

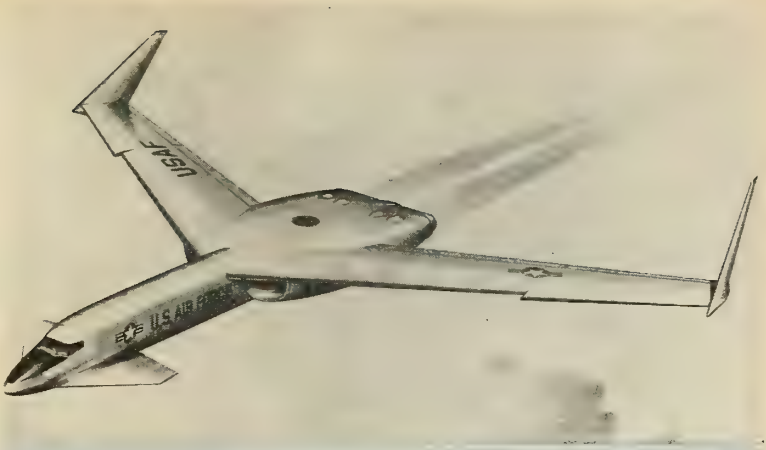
The Kennedy defense budget added $30 million to the *Dyna-Soar* budget—about one third of the amount sought. The new defense budget added only $132 million for unidentified advanced "space research and other projects." The *Samos* reconnaissance satellite program alone could have obsorbed most of it.

Thus the Air Force appears to be caught in an unhappy dilemma.

On one hand, the nuclear-powered aircraft program has been handed to the AEC, where it is being cannabalized for other programs and the remains buried. At the same time, B-70 has been reduced to an R&D insurance policy.

On the other hand, the Administration has so far failed to invest high-priority funds in advanced military space programs including manned spacecraft.

Somehow, with these prospects in view, the Air Force must revamp its strategy to fight a nuclear war in the late 60's. ⌘




## 'Fallout' from ANP Effort

The 14-year, $1-billion aircraft nuclear program has resulted in a long series of contributions to the field of reactor technology in general. Many of these contributions are being put to use today in the development of nucelar-powered rockets and other missile and space programs. The popular implication that the ANP program has been an extravagant waste is not founded on fact from the standpoint of "fallout" contributions alone. Some samples:

**SIZE**—The bulky and very heavy nuclear reactors designed for land or shipboard use have been greatly reduced in size and weight. Sea and land-based reactors weigh between 500 and 1000 tons. Reactors designed for aircraft have been reduced in weight to about 100 tons.

**SHIELDING**—Great quantities of data were collected in shielding experiments. Much of this is directly applicable to the design of nuclear-powered spacecraft and manned spacecraft that must pass through the earth's radiation belts as well as protect their occupants from other radiation hazards in space travel.

**METALLURGY**—The ANP program claims credit for such developments as a new nickel-molybdenum alloy that increases the operating life of reactors; new technology in the field of high-temperature liquid metal pumps, seals, heat exchangers and instrumentation; new corrosion data on various alloys with lithium, sodium, sodium potassium, lead, bismuth and various fused salts; techniques for fabricating large components of beryllium.

**FUEL ELEMENTS**—The ANP program developed the metallic dispersion fuel element now widely used in other reactors. Great refinements were made in the use of ceramics. Considerable work was accomplished in developing advanced manufacturing techniques. Development of the homogenous $BeO$-$UO_2$ fuel element which is expected to have wide application was started.

**REACTOR THEORY**—Much information was made available on calculational methods. One technique of reactor analysis that was introduced was the so-called C-5 program. Another was the "Multi-group One Dimensional Transport Theory (Reactor) Neutron and Photon Analysis." Heat transfer calculational techniques that were developed are now being employed in the *Pluto* nuclear ramjet project.

**SYNTHETIC OILS**—Considerable successful work was performed on the development of oils that could withstand the environment of a nuclear-powered aircraft for 1000 hours. Normal oils would congeal.

**ELECTRONICS**—Much data was collected on the effects of radiation on electronic components, and work was advanced on the development of components that can withstand the radiation environment. A wide application of this work to spacecraft is expected.

**SAFETY**—A number of significant fission-product dispersal experiments were conducted to determine the effects of the release of fission products from metallic fuel elements both in the air and on the ground. The results showed the margin of safety to be far greater than originally anticipated.

# U.S. Studies Ways To Gain in Race to Moon

***No immediate 'crash program' appears likely for several weeks; Congressmen seek budget boosts for NASA and AEC; moon landing seen possible by '67 if nation really wishes***

KENNEDY ADMINISTRATION officials are now conducting new inquiries into whether the United States can catch Russia in the race to the moon.

But, in the backwash of the Soviet manned orbital flight, one fact stood out clearly last week:

The United States still did not have a well-defined—and funded—program for manned space exploration keyed to, or presently capable of overtaking the Russians.

Moreover, there was no immediate evidence that President Kennedy would order a "crash" military or civilian effort within the next few weeks. The choices before Kennedy were multiple, but none appeared to offer hope for a "quick fix" to the problem—simply because there were no programs which would lend themselves to a speed-up.

On the other hand there was general agreement that a space station in orbit and a manned landing on the moon were the next major milestones in the race. The question before Kennedy was, who could achieve these objectives faster? NASA or the Air Force?

• **Money call**—In reaction to Russia's latest space feat, House Space Committee Chairman Overton Brooks renewed his call for a NASA FY '62 budget of $1.5 billion, compared to $1.417 sought by NASA—and the $1.25 billion actually allowed by Kennedy.

Other Congressional voices urged increases in Atomic Energy Commission activity on the Project *Rover* nuclear rocket, which is required to parallel the NASA work.

Rep. James G. Fulton (R-Pa.) predicted that the Space Committee will vote to authorize at least the NASA request of $1.417 billion, as well as additions beyond the request of $5 million extra for solid propellants and possibly additions beyond the request of $47.6 million additional for the *Apollo* three-man spacecraft.

Fulton conceded that the Appropriations Committee may not go along with every penny added by the Space Committee. But the GOP member maintained that Appropriations will probably point to the open authority in the authorization bill and tell NASA to come back next winter if it feels it needs more money.

• **1967—If we care enough**—The question of a crash program was first raised at the Space Committee hearings. Dr. Robert C. Seamans, associate NASA administrator who attended Harvard with President Kennedy, said he feels a lunar landing by 1967 is possible if the nation really wants it.

Seamans reported the Kennedy Administration already has cut a year from the lunar landing timetable and now has set the period 1969-70 as the target date.

Rep. David S. King (D-Utah) noted that Russia is reported to have set her sights on 1967, the 50th anniversary of the Communist Revolution. He asked whether America could do as well. Seamans replied:

"This is obviously a very major undertaking. To compress the program by three years obviously means greatly increased funding would be required. . . .

"I certainly don't feel this is an impossible objective. If as a matter of national policy this is felt to be a requirement, I would be the first to review it wholeheartedly and see what it would take to do the job. My estimate at this moment is that the goal may very well be achievable."

Pressed for an estimate of the cost, Seamans recalled that NASA Administrator James E. Webb had put an overall pricetag of $20 to $40 billion on a manned lunar landing—depending on how fast a program is scheduled. "If you go all out on an absolutely crash basis, the cost will go up," Seamans commented.

"We are talking about a program that will cost $4 billion to $5 billion a year," he added.

Meanwhile, the House passed and the Senate Space Committee approved a bill designed to make possible a Kennedy Administration review of the space program under the leadership of Vice President Johnson. The bill makes the Vice President chairman of the National Aeronautics and Space Council and restricts the members to five, the other four being heads of government agencies. Statutory members would be the secretary of state, the secretary of defense, the NASA administrator and the chairman of the Atomic Energy Commission.

• **No Ceiling Set**—Dr. Edward C. Welsh, executive secretary of the Space Council, said in an interview that Kennedy has set no ceiling on the nation's space program and has not by any means ruled out a maximum effort to reach the moon.

Welsh said that when Kennedy allowed only $126.67 million additional he was not ruling out further additions later. The Space Council official said it was simply a question of immediacy. Everyone agreed, Welsh said, that it was necessary to get going right away on the speed-up of the booster program because it was the longest lead-time segment of the program. Now, Welsh continued, the administration is considering segments with the next longest lead time.

• **Cuts pinpointed**—The House Space Committee last week made a detailed inquiry into the NASA program to establish details of the requests made to the Budget Bureau under the Kennedy revisions.

Seamans told the committee under

*(Continued on page 44)*

## *NASA New Obligational Authority*

| | 1961 (including supplemental) | 1962 Eisenhower budget | 1962 Kennedy budget | 1962 NASA request |
|---|---|---|---|---|
| | | (in millions of dollars) | | |
| Salaries & Expenses | $170.76 | $ 189.986 | $ 196.686 | $ 209.510 |
| Research & Development | 666.915 | 819.819 | 919.539 | 1056.309 |
| Construction of Facilities | 126.325 | 99.825 | 119.075 | 152.002 |
| Total | 964.000 | 1109.630 | 1235.300 | 1417.821 |

# Solar Wind Existence Is Proven

***NASA, MIT experts agree that satellite's measurements show force hurling from sun; new science of meteorology predicted***

**by Jay Holmes**

THE SOLAR WIND theory of the interplanetary magnetic field seems to have been confirmed by the findings from *Explorer X*, the rubidium vapor magnetometer satellite.

Scientists of the National Aeronautics and Space Administration and Massachusetts Institute of Technology reported last week that the solar wind in quiet periods seems to be about 10 particles per cu. cm., traveling at a speed of 30 km/sec.

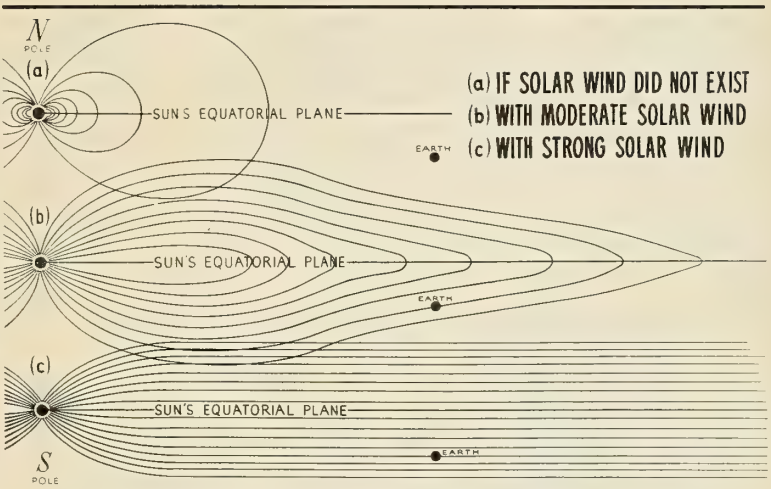
The satellite measured magnetic fields down to a minimum of 5 gammas in the region from 14½ earth radii out to its apogee at 36½ earth radii (145,000 stat. mi.). Such a measurement confirms that there must have been a solar wind flowing at the time of the flight—from the morning of March 25 until the evening of March 27, when the satellite's batteries burned out.

Dr. James P. Heppner of NASA's Goddard Space Flight Center, *Explorer X* project officer and director of the magnetometer experiment, said there is still a possibility that the solar wind occurs in gusts. But he declared there is no longer any doubt about the existence of such a wind.

The satellite also detected a period of violent disturbances in interplanetary magnetic fields beginning five hours before the appearance of a Class 3 solar flare. Heppner said the field jumped between 5 and 40 gammas during the disturbed period and on some occasions changed by 20 gammas within a few seconds.

About six minutes after the flare was sighted, the interplanetary field reverted from a disturbed condition to steady. Twenty-eight hours later, a sudden commencement (magnetic field disturbance) was recorded all over the earth. Two minutes after that, the sudden commencement was recorded by *Explorer X*, then more than 100,000 miles farther from the sun than was the earth.

The NASA and MIT scientists agreed that the sequence of events proved the sudden commencement was caused by something speeding out from the sun at about 3.26 million miles per hour.




*SOLAR MAGNETIC FIELD is drastically affected by flow of wind.*

Dr. Stanley Olbert of MIT reported that the *Explorer X* results seemed to indicate that the earth's magnetic field stretches out much farther than would be indicated by a simple dipole. One possible explanation, he said, is that the ring current from 6½ to 10 earth radii stretches out the field.

Dr. Herbert Bridge of MIT said the solar flare may have been a mixed blessing because it created more difficulty in the way of establishing what the interplanetary field is like during periods of solar quiet.

• **Transition data awaited**—Last week's report was based on analysis of about 10% of the tapes recorded by stations around the world while the satellite was operating. Data was reduced for the region between 3.8 and 6.5 earth radii and segments a half-hour to an hour long were reduced for several areas beyond 17 earth radii.

Data in the near region completely confirmed measurements previously made by *Vanguard III*, Heppner said. As a matter of fact, he suggested that in future flights a magnetometer might be converted to use as an altimeter in the near-earth region.

The earth's magnetic field is completely predominant in the near area, while in the more distant regions, the interplanetary field is predominant. No data has yet been reduced and translated for the transition region, believed to be from 15 to 20 earth radii. Olbert said that region will be the most interesting to scientists.

Heppner said the *Explorer X* data was not inconsistent with measurements of the interplanetary field made a year ago by *Pioneer V*. However, *Pioneer V* measured only the north-south component of the field and thus recorded only 2.7 gammas at a distance of about 24 earth radii.

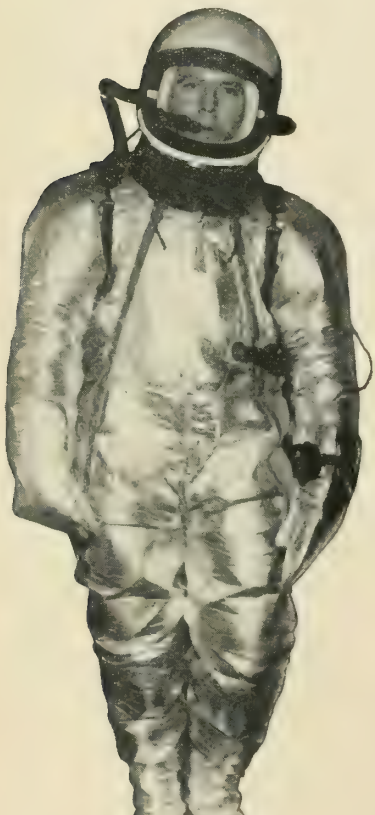
Dr. Charles Sonett, assistant director of the Goddard Center, predicted that a new science of interplanetary meteorology will be developed from findings about the fields and noted the obvious implications for predicting the hazards of manned flight.

All the scientists emphasized that more measurements at different times and on flights in different directions will be necessary to make firm statements about the nature of interplanetary space. The next such measurements will be made by *Ranger I* and *Ranger II*, to be launched later this year. ⁂

# AF Orders 'Quick Change' Space Suit

***Latex design, representing six years' work, is highly flexible and can be donned single-handed in minutes***

**by Heather M. David**



*LATEX SUIT is modeled by T/Sgt. Gene Fritz at Air Force's Wright Air Development Division altitude chamber.*

A SPACE SUIT which offers almost complete mobility even under full pressure has been designed by the International Latex Corp. for the Air Force.

So flexible a man could make delicate repairs to his spaceship while wearing it, the suit could be used for any space voyage planned for the next decade. It is adaptable to prolonged usage outside the space vehicle, on the moon or for interplanetary travel, according to its designers.

The biggest breakthrough offered by the suit is the mobility afforded the wearer in every joint. The intricately convoluted design of the joints of the inner layer is the result of some six years of work. The joints contain no heavy metal gimbals or cumbersome reinforcing straps and the total weight of the suit, boots and helmet is only 21 lbs.

Another advantage is that the suit can be donned quickly with no help. This makes it adaptable to the "shirt-sleeve" concept of space travel—in which the suit would be put on for hazardous periods or for work outside the vehicle. Project engineer George Durney said the donning time of several minutes would be fast enough to meet 90% of all foreseeable emergencies.

Oxygen supply can be obtained by hooking up the suit by umbilical to a vehicle supply, or attaching a separate backpan designed by the Garrett Corp. This backpan supply can be designed for almost any duration, but probably would average four to six hours.

The suit can be pressurized with pure oxygen to 5 psi. This compares to about 3.5 psi for the *X-15* suit and about 4.5 psi in the *Mercury* suit. Even under full pressure the wearer has tactile sense and mobility in his fingertips, but he must wear a protective glove when handling extremely hot articles.

The suit cooling system is continuous even when not under pressure and can be regulated to any degree by the wearer. Latex said it had been tested up to 35 minutes at 260°F without an appreciable rise in the subject's body temperature.

Material used in the suit is classified but basically contains layers of aluminized fabric, nylon and neoprene welded at the joints. Like existing suits, the outer layer is thermal radiation-reflective, but the manufacturers say it also protects against particle radiation. This protection is adequate to allow the crewman to emerge from his vehicle except during passage through the Van Allen belt and during a heavy solar flare.

International Latex has been working on the project under three Air Force Wright Air Development Division contracts totaling $250,000 for the past six years. ⁂

# Canada and NASA

## Satellite with 75-ft. Antennas to Ride Javelin

**by Bernard Poirier**

CANADA IS NOW designing a satellite with 75-ft antennas to probe the upper ionosphere in its first joint space experiment with NASA next year.

The *Longlegs* payload, part of the international *Top-Side Sounder* program, will record galactic emissions and other information valuable to improving long-range communications.

First details of *Longlegs* made available to MISSILES AND ROCKETS show the Canadians will employ a coiled carpenter's rule technique to extend the antennas in orbit. The technique will be tested in the nose cone of a *Javelin* rocket being launched from Wallops Island, Va., in June.

The girdled and flattened satellite, constructed principally of aluminum, is scheduled to be launched into a nearly polar orbit by a NASA rocket fired from Vandenberg AFB, Calif., in the first quarter of next year. Inclination will be 80° at an altitude of 625 miles and the orbital period about 105 min.

Built by the Electronics Laboratory of Canada's Defense Research Telecommunications Establishment (DRTE), *Longlegs* will have two sets of antennae. The second will be 37 ft.

*Longlegs*' sounder uses miniaturized radar transmitting sounding pulses and measuring the echo's return time. This data will be relayed by four 20-in. telemetry antennas to ground stations at Resolute Bay, Prince Albert, Ottawa, St. Johns, Alaska, Florida, Chile, Ecuador, England and Malaya.

The special antennas are made of thin heat-treated steel, coiled on drums for automatic extension. Uncoiling after separation, they will then form themselves into rigid tubes extending through specifically-designed guides, say the Canadian scientists.

• **Beacon fixed**—*Longlegs* will resemble a flattened sphere and will be girdled by banks of solar cells. The diameter of the girdle will be about 42 ins. and overall weight will approximate 270 lbs.

Objectives of *Top-Side Sounder* are to (1) examine and record fundamental scientific information about the structure of upper levels of the ionosphere by radio sounding techniques and (2) provide information about galactic noise or radio signals that emanate from outer space.

In addition, payload space has been allotted for instrumentation developed

*(Continued on page 44)*

# NASA Gives Go-Ahead to Segmented UTC Motor

A CONICAL, flight-weight segmented solid motor of 250,000 lbs. thrust will be test-fired by United Technology Corp. late next summer.

UTC, a subsidiary of United Aircraft Corp., will build the motor under a development contract from the National Aeronautics and Space Administration. The three-segment unit will weigh over 75,000 lbs. and operate for more than 60 seconds.

UTC spokesmen say it is the initial step in the development of a family of low-cost solid boosters. The largest of these motors could deliver more than 3 million lbs. thrust; clustering could up this to a booster stage with more than 15 million lbs. thrust.

The segments in the first test motor are coupled through a circumferential clevis joint. The rim of one case-segment fits into a notch in the next section. The notch also holds a simple "O" ring and the joint is made fast by inserting shear pins in previously drilled holes. A pin retention strap completes the assembly.

UTC recently completed a feasibility program (M/R, June 13, 1960, p. 35) which involved the design, fabrication and test-firing of three flight-weight, conical, segmented motors of 15,000 lbs. thrust.

Each of the three motors had three segments and all were successful.

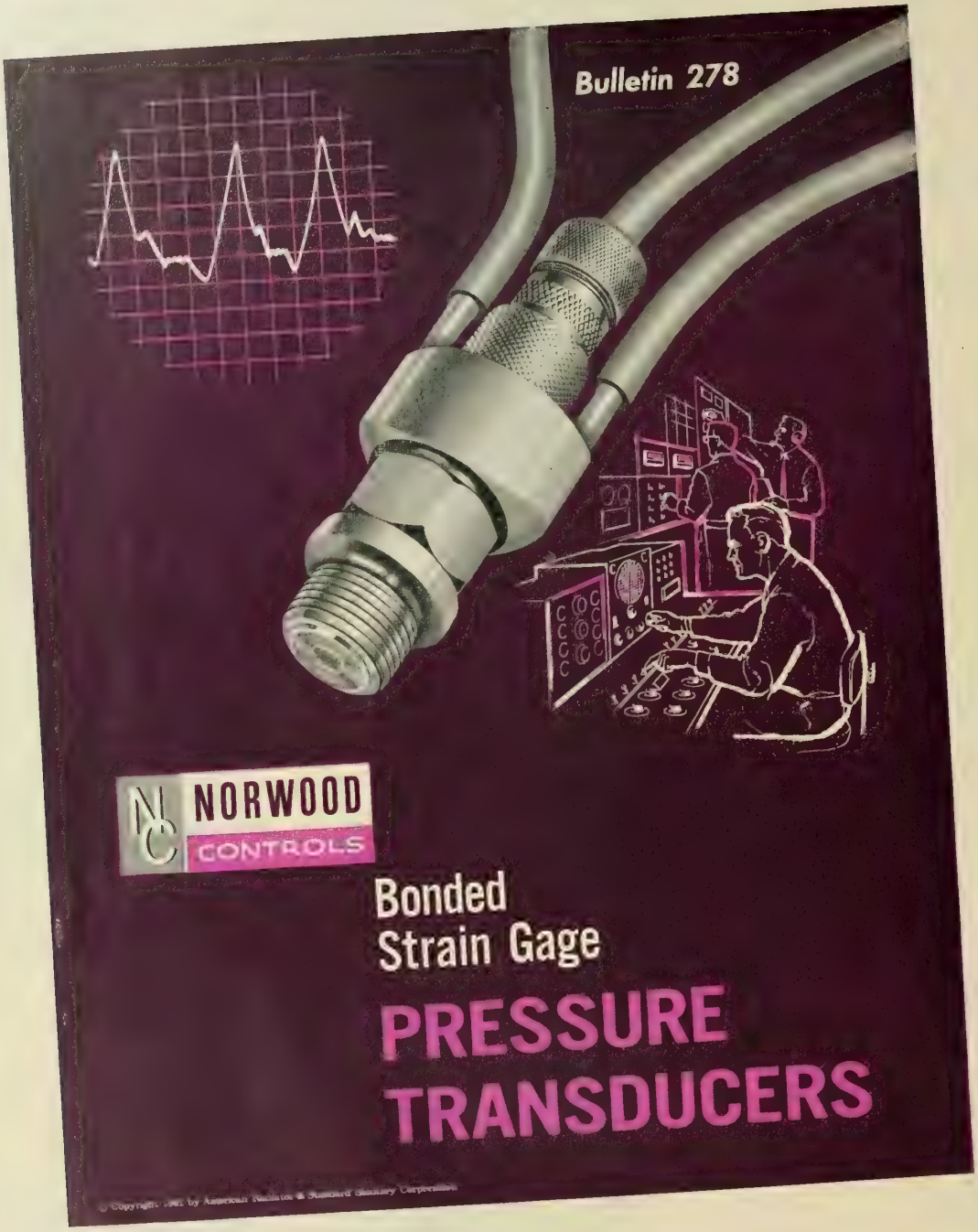
The conical shape eliminates erosive burning in long solid grains. The propellant thickness is the same for the length of the motor. The gas flow channel is cone-shaped, with the narrow end at the head of the unit.

The program is expected to provide additional information in many areas including propellants, segmentation joints, large uncooled nozzles and ignition methods. Work will be carried out at the firm's new research and development facilities on the San Francisco peninsula. ⌗



*FULL-SCALE MOCK-UP of three-segment, conical solid motor shows characteristic tapered UTC configuration. Single motors could develop 3 million lbs. thrust.*

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# Technical Countdown

## SUPPORT EQUIPMENT

### BMEWS Radar To Track Satellites

The prototype BMEWS tracking radar built by RCA at Moorestown, N.J., will be used to detect and track satellites for the Air Force. Initially, a three-month study program will determine the capability of the huge radar as a space surveillance aid. The facility has already tracked the moon, earth satellites, and missile and rocket launchings from Canaveral and Wallops Island during its prototype test phase.

### Titan II Has Own Weatherman

Martin-Denver has installed a complete weather observation and forecasting station for the *Titan II* test program. A four-man meterological team will predict weather for scheduling static firing tests and observe conditions during tests as an aid in analysis.

### Flat-Screen TV Display Developed

A new approach to flat-screen optical displays, using molecular electronics, has been developed by Electro-Tec Corp. Details have not been revealed, but the development is reportedly so basic that it could have a significant effect on a wide variety of materials and instrumentation—including the obvious TV screen hanging on the wall.

### AF Simulator Combines Missile Torture Tests

A new simulator developed for realistic testing of ballistic missile components can simultaneously provide steady acceleration, vibratory acceleration, and extreme temperatures. The unit consists of a 450-lb. force electrodynamic vibrator and high-temperature oven mounted on a large-mass centrifuge.

### Missile Checkout Methods Applied to Aircraft

The Army is studying the use of electronic checkout techniques developed for missiles to preflight-test aircraft. Bendix is researching the ALARM concept, which will automatically check flight readiness of critical mechanical and structural components.

### Transit Equipment for Polaris Subs

Million-dollar test instrumentation equipment for the new 616 class of *Polaris* nuclear submarines will include receivers for *Transit* satellite navigational data. Sophisticated second-generation instrumentation leans heavily toward digital equipment for recording and data reduction. Nine systems will be built by Interstate Electronics Corp. under a $9.5-million contract.

### Telemetered Data Relayed Cross-Country

Telemetered test data received from *Hound Dog* missile flights at Cape Canaveral is relayed instantaneously to North America's headquarters at Downey, Calif. The new system allows NAA engineers to monitor the missile's flight while it is in progress and analyze critical data within five minutes.

## ELECTRONICS

### Accurate RMS Measurements

Newest development out of the National Bureau of Standards is r-f thermal voltage converters for accurately measuring rms voltages. The converter—a resistor in series with a thermoelement in a coaxial line—can measure rms voltages of 1-200 volts at frequencies up to 30 mc. Accuracies are 0.1% at the low end and 0.2% at the high.

### Circuit-Board Production Speeded

Production of printed-wiring boards has been more than tripled at Lockheed by improvements in manufacturing techniques. New methods include multiple hole-drilling, automatic soldering and cleaning, and single-operation tabbing of inserted wires.

### Seawater-Bacteria Battery

There are unconfirmed reports that a method has been found to extract energy from the ocean by use of an "oceanic battery" composed of iron cathode coated with bacteria and magnesium anode. The battery gets energy from naturally occurring ions in some ocean solids—nitrates, carbohydrates, sulphates, and others. Power output is said to be five times that of ordinary magnesium types.

## ADVANCED MATERIALS

### Russians Using Glass Fibers in Nuclear Fuel

Nuclear fuel elements made of glass fibers containing oxides of uranium 235 have been tested in Soviet nuclear reactors. The approach makes it possible to operate the reactors at temperatures up to 1000°C. The Russians are also looking into incorporating the oxides of thorium and plutonium with the glass fibers.

### Sulfur Belt in Stratosphere

The Air Force has discovered a world-wide aerosol layer consisting mainly of sulfur particles. The 3-mile-thick shell completely surrounds the earth at an altitude of about 11 miles. The layer, which also contains silicon, iron and aluminum, may explain certain twilight effects such as the red disk frequently seen above the point of sunrise or sunset.

### Magnesium-Lithium Alloys for Space

Battelle Memorial Institute metallurgists suggest that Mg-Li alloys would be valuable for lightweight, light-load carrying space structures. The alloys resist spalling and penetration by high-velocity fragments. This could be useful in micrometeoroid shielding.

## PROPULSION

### Saturn Upper Stage Model Cluster Fired

Simultaneous ignition of a four-engine, hydrogen-oxygen, scale-model cluster has been achieved by Marquardt Corp. The model was built for Douglas to determine the effects of the intense heat of the S-IV engines on the structure and systems in the vehicle's base at altitude.

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# NBS Plans Basic Propagation Studies

***Bulk of Kennedy-proposed budget addition would go to Boulder Lab for program of fundamental research***

**by Hal Gettings**

A PROPOSED increase of $750,000 included in President Kennedy's revised Fiscal Year 1962 budget request would add considerably to the knowledge needed for practical satellite communications.

The National Bureau of Standards would use the money to find the answers to some basic problems in radio propagation in space.

NBS says this basic information is a prerequisite to intelligent frequency allocation and the development of optimum equipment and techniques for space telecommunications systems.

The funds are not yet in hand; budget hearings to be held soon will decide the fate of the program.

NBS contends that current needs in this fast-developing area indicate that the effort must be expanded by $4-6 million, but that such an acceleration would be impossible within a single fiscal year.

The bulk of the additional money—$650,000—would be used for operating costs. Only $100 million would go for new equipment.

The proposed Bureau program does not include the launching of any satellites purely for propagation experiments during the first year. Possibly, however, specific experiments might ride on satellites launched for other projects.

The program would be conducted by the Bureau's Central Radio Propagation Laboratory, Boulder, Colo. Proposed investigations would center around several important facets of the problem:

—Research in atmospheric absorption. Influence of the atmosphere on radio propagation at frequencies above 10 gc (kmc) becomes increasingly important as the potential use of these frequencies for space communications grows. At frequencies above 1 gc, present rates of atmospheric absorption and sky temperatures are based on limited models of the earth's atmosphere. NBS says it is necessary to expand these data as a function of time and climatic conditions and to correlate the radio and meteorological measurements. These measurements should be designed to develop methods, based on simple meteorological measurements, to predict performance of a space communication system with terminals located anywhere on the earth's surface.

—Extension of tropospheric propagation theory to space communication systems. Present tropospheric propagation theory is the result of extensive theoretical analysis of data on the dependence of system performance on many variables such as frequency, distance, antenna heights, topography, and meteorological conditions. This work, extended to space telecommunications problems, would take into account satellite heights, atmospheric disturbances, changes in refractive index, and turbulence.

—Mutual interference between surface and space communication systems. The possibility of interference between surface and satellite systems operating on the same frequencies requires the prediction of interfering fields. Limits of interference must be known in order to assure adequate safeguards for the systems involved and, at the same time, make efficient use of the frequency spectrum. The widely divergent results predicted by currently available theories can be resolved only by actual measurement of results. In particular, it is important to determine the extent of low-transmission losses which may occur when the very narrow beams of large antennas are directed well above the horizon.

• Application of modulation studies to tropospheric terminal equipment. Owing to a large radio wave transmission loss and the fading characteristics of the received radio signal, present-day multichannel tropospheric radio communication systems require comparatively high transmitted radio-frequency power for effective operation. High-gain antennas and various diversity schemes have partially overcome these difficulties, but they add substantially to the cost and complexity of the systems. A very promising area for improvement, however, is believed to be in the radio receiver. The proposed project would include standard comparison tests on wideband radio receivers to determine which type gives the best performance. Various types of improved demodulation methods also will be considered.

• Radio meteorology. Although only indirectly related, fundamental knowledge of tropospheric propagation is important in connection with problems of tracking and communication with satellites and missiles. The increased program would permit more adequate investigation of the combined effects of temperature, wind, atmospheric pressure and refractivity on radio propagation.

• Radio noise. Increased attention would be given to the measurement of external radio noise and its effect in limiting the usefulness of various types of communication systems. Study would include the three principal types of radio noise: man-made, atmospheric, and galactic. Increased effort on noise measurement techniques and analysis of data is also planned.

• Modulation research for satellite communications. The problems to be encountered in this area arise from the fact that effective world-wide communications through the use of satellites require that wideband systems capable of handling large quantities of information be developed. Methods of encoding the information and modulating the r-f carriers must be designed with due consideration for the perturbations imposed on electromagnetic waves propagated through space.

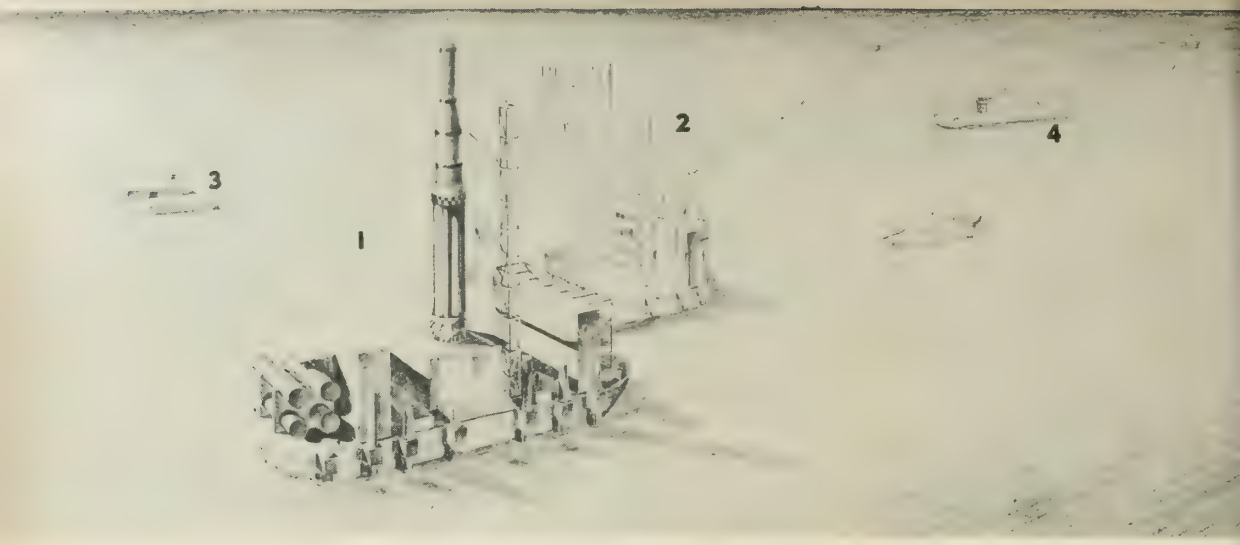
• Antenna research. The weightless, frictionless environment of satellites makes possible unique antenna designs. These are important factors in improvement of communication systems design because of their significant role in determining power requirements and interference effects.

NBS has some weighty arguments on the side of an increased effort in space communications research.

President Kennedy, in his State of the Union message, invited all nations to "join with us in developing . . . a new communications satellite program and in preparation for probing the distant planets. . . ."

James M. Landis, in his report on the regulatory agencies, called for improved coordination and development of communication policy and better control and allocation of the radio-frequency problem.

*(Continued on page 48)*




*FLOATING DRYDOCKS for launching Saturn-class vehicles includes AFDB's for (1) launch platform, (2) service platform, (3) blockhouse. An ARD drydock (4) is used for vehicle transport and assembly.*

## sea launching

# Flexibility Behind Idea For Drydock Platforms

**by William Beller**

THE IDEA of launching large space vehicles from water-borne mobile platforms is still being considered seriously by the Defense Department and the civilian space agency—even though there is no money for the project.

Such platforms continue to offer the beguiling advantages of flexibility in chosing a launch site and minimum hazard in the event a large rocket explodes or a prospective nuclear rocket aborts.

Any agency is keenly appreciative of these advantages when it is charged with attaining specific orbits for its satellites and also with continuously protecting its launch crews and the native population.

Meanwhile, the Navy's Bureau of Yards and Docks and also the Pacific Missile Range have been proposing ways to use some of the mothballed floating drydocks as economical mobile launching sites. Much merit is seen in their proposals, especially because these docks are equipped with many of the shops and facilities needed for ground support equipment.

Commercial organizations have also seen the possibility of using Navy vessels as launching sites. Among these are Boeing, Douglas, Hayes Aircraft, and the company of Daniel Mann, Johnson and Mendenhall.

The towable docks the Navy uses to drydock its ships, chiefly at remote locations, can be stabilized in shallow water by DeLong-type spuds which would jack the docks partly out of the water.

• **Water versus land**—Here are some of the ways in which the mobile launch may have the advantage over the land-based launch of a space vehicle:

—When a specific orbit, such as equatorial, is wanted, the launch point can be appropriately chosen. There is no need to dogleg the satellite from an inclined orbit, and therefore no weight or reliability penalty.

—Hazards can be reduced—particularly those that endanger populated areas by explosions, spread of propellant combustion products, exhausts from possible nuclear jets, and hardware fallout from an aborted flight.

—With the cost of real estate continuing to rise in populated areas, the price of enlarging the launching bases and buying buffer areas as a shield against hazard and noise is already prohibitive; a water-borne launch, particularly at a remote location, will be relatively economical.

—Covert tests can be made with maximum security.

Other advantages stem from the fact that building fixed overseas bases—which might be necessary to accomplish launch objectives—brings in political as well as cost problems. Base rights have to be negotiated for; facilities once built have only small salvage value to the United States.

On the other hand, stationing the mobile base in international waters would not only lessen political problems but also the facility would be 100% salvable.

Moreover, the complete facility can be checked out stateside, close to equipment manufacturers and management headquarters. Also, by building the facilities in stateside shipyards and thereby eliminating foreign construction work—work whose cost is said to range from 2.5 to 3 times stateside cost—there are

savings in money as well as time.

• **Drydocks get the nod**—BuDocks has studied two types of launchings; those in the *Centaur* class and the *Saturn* class.

For the *Centaur*-class vehicles and those up to 1.5 million-lb thrust, the BuDocks' concept calls for using an ARD floating drydock. These ARD's have been drydocking destroyers since the beginning of World War II and have tens of thousands of operational hours to their credit. They are nearly 485 feet long and can take on a load of 3500 tons.

When drydocking a destroyer, the ARD—which is simply a hollowed-out hull with its aft end a watertight door—takes on water until its deck sinks and the destroyer is floated aboard. Then the hinged door is closed, water pumped out of the ARD, and the destroyer is raised clear of the sea.

BuDocks says that an ARD, which can be towed up to 11 knots, can carry two or three *Centaur* types to a launch site. All facilities on board will have been assembled and checked out stateside.

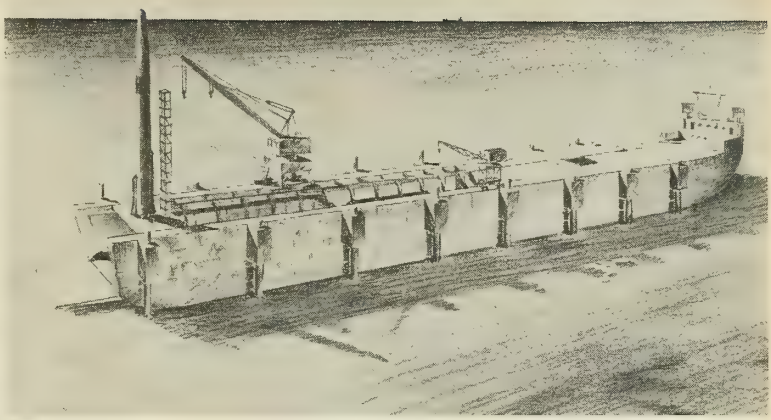
On site, the drydock will be stabilized by DeLong-type jacks and caissons, which will be hydraulically controlled. In effect, this system of spuds takes on a small part of the buoyant load and lifts the drydock a foot or so higher in the water. These spuds can be used in water up to 200 feet deep.

Captain Harry Stevens, Jr., director of BuDocks' engineering division, and John Filipowski, BuDocks architect, emphasize that the launch pad on the ARD will be useful for larger vehicles as well as for *Centaur* types. A water-cooled or dry deflector will pass the rocket's exhaust aft over the stern gate. The obvious approach of shooting the rocket exhaust directly into the sea is not used because of its scouring effect on the stabilizing caissons.

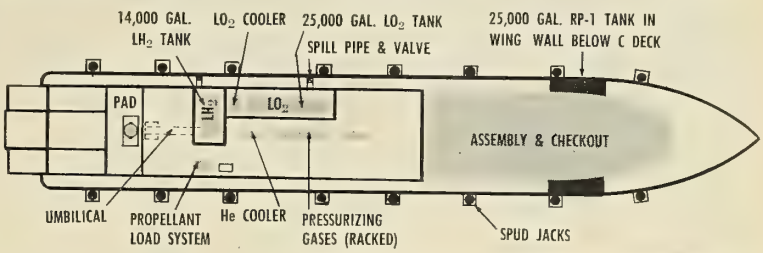
The "blockhouse" aboard the ARD, modified for overpressuse, can be located in the bow. Fuel tanks, cranes, and a retractable gantry can all be part of the facility.

Not a cubic foot will go to waste. Shop areas without a launching func-

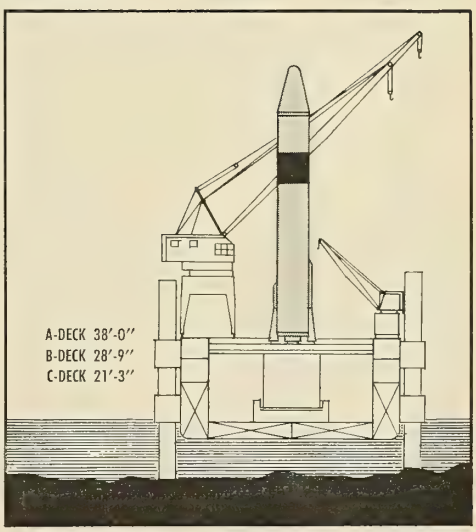
*(Continued on page 48)*



*ARD DRYDOCK suitable for servicing and launching Centaur-class space vehicles is stabilized by a system of DeLong-type hydraulically controlled spuds.*

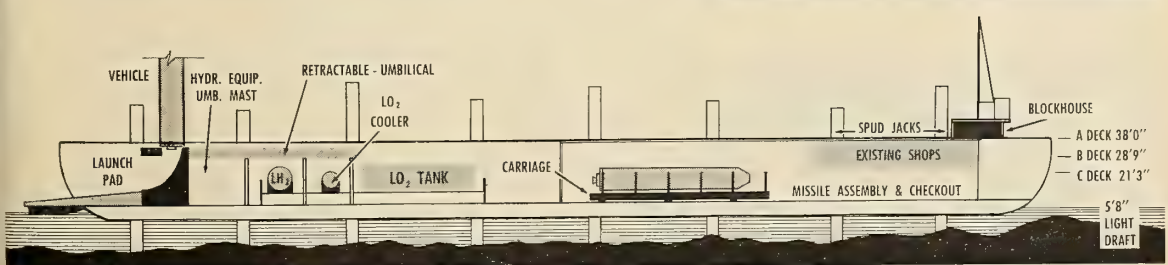



**ABOVE:** *ARD plan shows stowage for propellants and locations of spuds.*




**RIGHT:** *Existing cranes are adequate for handling Centaurs.*

**BELOW:** *Section view shows jet deflector which can be either water-cooled or dry.*



# *RELIABILITY in depth, from*




**NIKE ZEUS**
Army's Anti-Missile Missile
Prime Contractor: Western Electric
Missile: Douglas Aircraft

**ARMY**

Scientific and engineering groups at Thiokol, fu
tioning as part of the Army Ordnance team, h
developed propulsion systems of total reliability
a wide range of military requirements. Motors
Lacrosse, and for the developmental Sergeant
Pershing, the modern field artillery—powerplants
the Nike Hercules and Nike Zeus, defenders agai
air borne and ballistic missile attack . . . these
products of the joint Army-Thiokol effort. Additio
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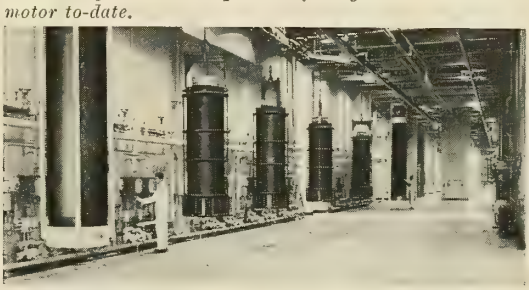
# research through production



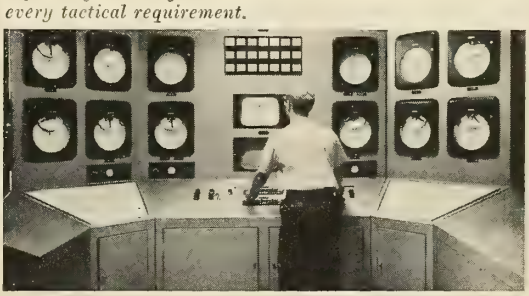

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# Direct Winding May Cut Case Cost

***Filament technique under development by Grand Central and Aerojet would obviate need for making propellants withstand broad temperature range***

**by Frank G. McGuire**

LOS ANGELES—Cost of glass motor cases may be sharply reduced by filament winding directly onto a solid-propellant grain.

Grand Central Rocket Co. and Aerojet-General Corp. are developing the technique, aimed at eliminating stresses in the final product. They warn that several problems must still be solved before its full money-saving potential can be realized.

Charles E. Juran, of Grand Central, says the chief advantage of the method is that it sidesteps the need for making propellants capable of meeting broad temperature ranges.

Ralph J. Brown, Jr., head of preliminary design at Aerojet's Structural Materials Division, reports that good results were obtained in the firing of a small test motor last October; a 90,000 psi composite stress was withstood by the solid rocket during firing.

Crux of the problem is that differential thermal shrinkage between propellant and case during cool-down from curing introduces stresses in the propellant which are sometimes great enough to cause cracking or separation from the case wall.

In addition to the actual cracking or separation, Juran said, the stress levels can cause marginal grains which are sensitive to minor stress concentrations or operational loads. This is particularly noticeable in large motors.

Current practice is to use rubber liners, mechanical stress relief, pressure curing and other techniques to alleviate the stresses. In all these methods the shrinkage is permitted to take place; attempts are made to design cases around the problem.

In the technique under development at GCR, the case is filament-wound directly on the pre-cured grain at ambient temperatures, then stressed only to the extent that the motor deviates from that temperature.

Juran described the application as a logical one, merely substituting the precast grain for the mandrel which would be used to wind the case anyway.

Aside from the basic advantage to be gained, GCR is looking toward improvements in mass ratio, resulting from elimination of rubber liners, winding the case and nozzles integrally, and other weight-saving steps.

Modified grain design to take advantage of eliminated stress considerations is also to be expected, Juran says, pointing out that the grain designer is presently severely limited by stress restrictions in the geometry of the propellant core.

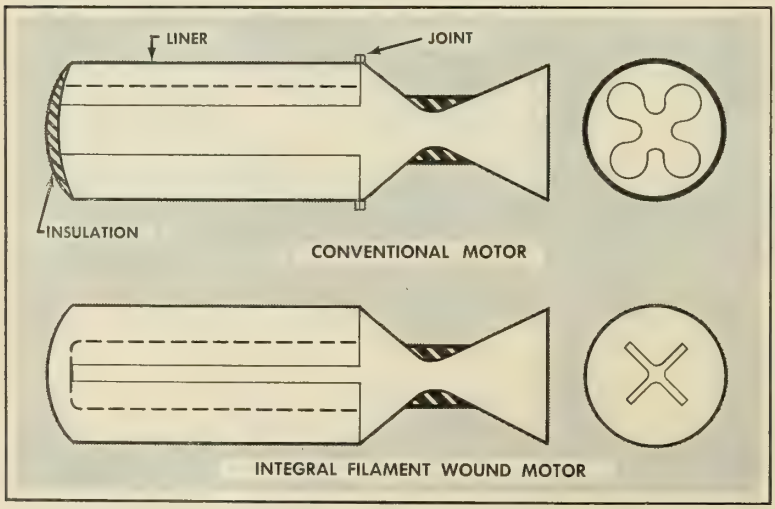
The technique is compatible with mass production.

• **Problems remaining**—Still to be solved before the application is finally put into common use are problems of safety during manufacture, resin cure techniques, inspection, and compatibility of materials with propellants.

Fabrication safety obviously centers around the undesirability of carrying out extensive operations on a live propellant charge.

A production problem is that of curing the resin in the system without simultaneously elevating the temperature of the grain. The compatibility problem, in addition to chemical considerations, includes adequate bond strengths. No insurmountable obstacles are expected in this area because the multiple-use resins to be used in the filaments have previously been used directly on propellants for bonding and inhibiting.

Geometry of the winding pattern is expected to be quite similar to that which would be used if the grain were an inert mandrel. The principal concern is careful handling and physical support of the grain itself, particularly those very large grains where stress-




*CUTAWAY DRAWINGS of conventional and integral filament-wound motors, with cross-sections of grain at right. New method is expected to improve mass ratio.*



*REINFORCED PLASTIC nozzle liner produced by Tapco Group has been worked into Antares third-stage Scout 29.5-in.-diameter exit cone by Allegany Ballistic Lab.*

free features are most desirable.

Where the grain cavity diameter is not greater than the diameter of the throat nozzle, a modified mandrel with end support pins can be used. In cases where this cannot be done, a segmented mandrel is feasible, being removed after winding is complete. Even a soluble or fusible type of mandrel could enter the picture.

If insulation should be desirable in the finished motor, such materials can be applied directly to the grain before winding. This is easier than trying to lay up insulation inside a chamber, where access and inspection are difficult.

• **Curing the case**—Most critical phase of the operation will be the winding cure, which must be adequate to utilize as much strength of the resin as possible, while maintaining enough of a safety margin to prevent grain deterioration or even autoignition.

The process must also insure that return to ambient conditions does not introduce the very shrinkage problems which the technique is designed to avoid.

Juran points out that variations in resin curing techniques may have to be found, including possibilities of using ultraviolet or infrared radiations. Effects of these on propellant must first be ascertained, he said.

Combining high strength with reasonably low curing temperatures has been the prime influence in past selections of resin systems. However, even though epoxy cure temperatures are in the range of 180 to 370°F, which is well below autoignition points of propellants to be used, there is still a problem from accelerated aging or cure shrinkage in the propellant.

Juran proposes radiant heat lamps for surface curing of the case, rather than in an elevated temperature atmosphere, due to the necessity for curing the wound surface of the grain but not the surface of the core itself.

Pigments in the resin are suggested as a method of preventing excess heat transfer from the filament to the grain, but pigments would also retard inspection.

Reduction of the thermal range requirement to 55% of the former value is another advantage to be expected from the ambient-temperature winding technique.

As an example, Juran cites a conventional cast-in-case propellant poured at 180°F, which military requirements say must withstand temperatures to as low as −65°F. The charge drops 110°F during curing, then is expected to be fully usable to −65°F, amounting to a temperature range of 245°F.

If the same charge were filament-wound in a stress-free condition at +70°F, still with the operational requirement of −65°F, the range would be greatly reduced.

• **Mass ratio improvements**—An improvement in inert weight factors would result from elimination of the insulation, lining and various bits and pieces of hardware used during manufacturing operations. Steps in fabrication are also cut out in the process.

Improved volumetric loading of grains would be another gain from introduction of the technique, which presents ways of sidestepping the limitations placed on designs with a given chamber area.

Present grain configurations must maintain thin, flexible webs, resulting in low volumetric loading, and large radii of curvature, causing large sliver losses.

Design considerations are currently more restricted by thermal cycling problems than by ballistic requirements.

Grand Central's development was described by Juran at a symposium of the Society of Aerospace Material and Process Engineers. ⌘

## Record Saturn II Contract Award Expected in Autumn

A CONTRACT for the largest rocket ever built by private industry—the 800,000-lb.-thrust *Saturn S-II* stage—is expected to be awarded in October or November.

The M/R estimate of total cost is $220 to $240 million.

Under a speedup ordered by President Kennedy, the National Aeronautics and Space Administration held a pre-proposal conference at Huntsville last week. Initial proposals are due at the Marshall Space Flight Center May 11.

From the early proposals, which will outline companies' capabilities and past experience, NASA will choose a smaller number of companies to submit detailed bids with cost information.

Specifications for the *S-II* stage are still being written. However, this much is known:

The rocket will be 74 ft. long and 21½ ft. in diameter. It will have the capacity to carry 350,000 lbs. of LOX and liquid hydrogen propellants to power the four Rocketdyne J-2 engines, which will have specific impulse slightly over 420 sec. Thus, the stage will have propellant capacity for about 180 sec. of operation.

The stage weight will be 30,000 to 45,000 lbs. unloaded.

First flight test of the *S-II* stage—with live *S-I* and *S-II* and dummy *S-IV* and *S-V*—is scheduled for 1964. A seven-flight program has been laid out with the idea of making the *Saturn C-2* vehicle operational in 1966.

*Saturn C-2* is to have a boost capacity of 45,000 lbs. in orbit, 15,000 lbs. to escape velocity and 10,000 lbs. on a probe to Mars or Venus. However, the vehicle is to be especially designed for its escape capacity, since its most important mission is to boost the 15,000-lb. second-phase *Apollo* manned spacecraft on a mission around the moon. It also will have the job of boosting the *Prospector* mobile remote-controlled lunar landing craft for unmanned exploration of the moon.

To date, there have been full 200,000-lb.-thrust firings of J-2 thrust chamber, full-scale fuel pump tests and model tests of other components. NASA propulsion specialists report the work is right on schedule.

NASA invited 20 companies to the pre-proposal briefing:

Avco, Bell Aircraft, Bendix, Boeing Airplane, Chance Vought, Chrysler, Convair, Douglas Aircraft, Firestone, General Electric, Hughes Aircraft, Lockheed Aircraft, Martin, McDonnell Aircraft, North American Aviation, Northrop, Raytheon, Sperry Rand, United Aircraft and Western Electric.

# Data Lacking on Combustion Problems

NEWPORT BEACH, CALIF.—Possible effects of erosive burning in solid rockets and ignition in confined pores within propellants is causing some concern to designers of future large boosters and motors having ultrahigh-burning-rate propellants.

Papers presented at the spring meeting of the Combustion Institute's Western States Section, held at the Aeronutronic facility here, showed a lack of complete technical data on both problems.

Limited to 12 formal papers and a number of short presentations on recent work, the meeting drew over 120 participants from industry and other research groups.

Significance of erosive burning in the accurate prediction of performance curves for solid-propellant boosters was described by Drs. E. J. Fenech and J. S. Billheimer of Aerojet-General Corp., who emphasized that much more data on actual firings is needed before the phenomenon is completely understood.

Dr. Fenech noted that the configuration of the flow cross section in the grain core greatly influences the magnitude of erosive burning, in addition to the classical effect of burning rate on the erosive constant.

A lively cross-fire discussion brought general agreement that there is some characteristic length which identifies erosion flow in each grain design, similar to the hydraulic radius concept of annular flow channels.

However, in rocket motors the relation of mass addition from a receding boundary surface overshadows the conventional Reynolds analogies, Billheimer stated.

C. A. Saderholm, of Thiokol's Redstone Division, also presented data on small-scale tests of propellant tablets for erosive burning characteristics.

Final consensus was that considerable work remains to be done in formulating a true boundary layer condition to obtain accurate erosive burning coefficients for use in designing motors of minimum overpressures for application in future high-thrust solid propellant boosters.

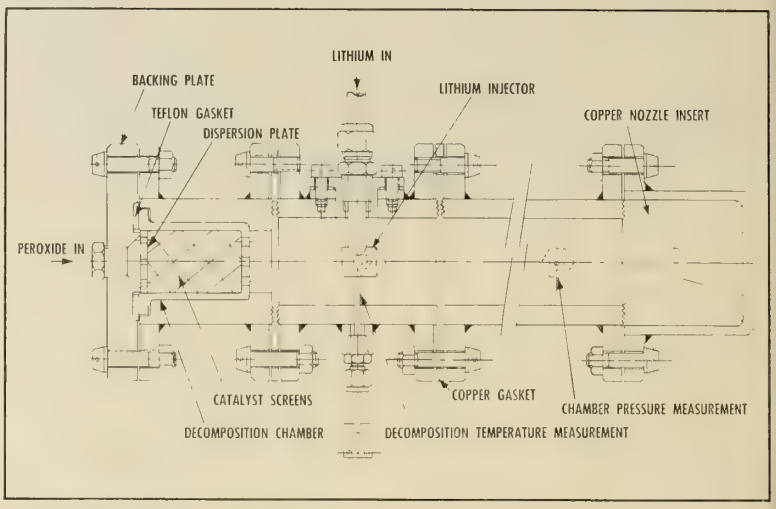
• **Runaway phenomena**—A complex situation of ignition and burning in confined pores of propellant was laid out by G. D. Artz and F. B. Cramer, of Rocketdyne. Approaching the problem on rigid thermodynamic grounds, the authors considered effects on a high-burning-rate propellant of ignition in small cylindrical cavities unavoidably present in the propellant.

Crux of the difficulty is the disputed ability of a flame to enter and hold in such a cavity, thus producing pressure that would propagate the minute crack and cause increasingly greater structural damage until the motor is rapidly destroyed. The ability of flame to enter such a small pore was disputed, but data is not yet sufficient to prove either case.

The possibility that flame might enter and cause structural damage through such pores would present a runaway burning-rate problem of first magnitude; there is now no way to completely prevent such pores from occurring in rocket motors.

Cramer pointed out that there is every reason to expect a high incidence of 200 to 400 micron flaws in the best of conventionally processed propellant, which do not present problems at burning rates now in use. However, when burning rates reach the range of five to 20 inches per second, flaws of this magnitude could be disastrous.

• **Lithium as propellant**—"After many years of idle discussion, lithium is finally receiving the degree of research activity which is warranted on the basis of its unique combination of physical, chemical, and thermodynamic properties," said M. C. Hardin and A. I. Masters, of Allison Division, General Motors, who presented encouraging research data to back up the statement.




*SCHEMATIC shows how Allison system used liquid lithium as rocket fuel.*

The authors presented results of studies showing lithium to have application as:

—High-energy solid-propellant additive

—Storable liquid bipropellant additive

—Fuel for operation in high temperature environments

—Fuel for hybrid rocket engine

—Propellant for a nuclear or chemical-nuclear rockets

—Working fluid for cooling, heat transfer, heat storage, or other similar applications.

Like other papers presented at the meeting, the GM report cited the lack of complete research data. Additional development, the authors said, will depend on complete determination of thermodynamic data for the lithium reaction products and a more detailed examination of the problems involved in handling the metal in its various states.

Describing rocket engine tests with the metal as a liquid fuel and hydrogen peroxide as oxidizer, the authors say uses of liquid lithium as a fuel in specialized rocket applications is feasible.

• **Rocket test setup**—The laboratory setup at Allison consisted of a 200-lb.-thrust motor using liquid lithium heated to 500°F and injected into a gas stream of decomposed hydrogen peroxide. Since lithium is more readily han-

dled in the liquid form than most metals, there was no need for a slurry carrier, solid propellant binder or other techniques.

The uncooled motor was kept as small and simple as possible, yet large enough to obtain valid data. Operating time was less than ten seconds.

Allison showed some concern over burnout of combustion chambers during firing; this turned out to be justified. Of two rocket motors used, one of .35 inches diameter and a second of 3.50 inches diameter, the smaller one was limited to runs of less than three seconds because of chamber burnout or extreme nozzle erosion.

A total of 36 bipropellant runs were made during the Allison study, which used a theoretical $I_{sp}$ of 260 at 500 psia chamber pressure. The engine accordingly was made with a throat area of 0.269 square inch, and a lithium flow rate of 0.25 lb./sec with hydrogen peroxide flow of 0.51 lb./sec were established.

The 90% hydrogen peroxide was injected into the motor through a catalytic decomposition chamber, where it was broken down into oxygen and water vapor at about 1360°F. A variety of lithium injectors were tested, using a single point injection into the center of the $H_2O_2$ stream.

Combustion chambers segments of various lengths provided characteristic lengths in a range from 50 to 300 inches.

Nozzle materials tested included copper, graphite and plasma-sprayed tungsten over graphite. A water cooled nozzle was used at one point late in the program.

Allison said 21 runs were made with the smaller engine, and all nozzles showed extreme erosion. A larger chamber was designed on the theory that greater flexibility of injector design would not present a danger of lithium impingement, and in addition a larger chamber would reduce gas velocity at the exhaust nozzle entrance.

Moving to the larger diameter chamber practically eliminated chamber burnout and reduced nozzle erosion, although the latter remained a problem. With tungsten-coated graphite nozzles in the 3.50-inch chamber, nozzle erosion was reduced to a three to ten percent diameter increase in three to seven second runs.

Fuel/oxidizer ratios were varied widely during the 36 runs in both chambers, the two propellants being hypergolic. A pyrophoric characteristic of the vaporized liquid lithium was also apparent during the studies.

Stable combustion was apparent throughout the tests, with high frequency oscillations limited to one to five psi amplitude at 800 to 1000 cps. ⠿

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# USSR Geared to Press Space Lead

***'Super agency' for research appears to have new overall authority; MIT's Trilling outlines implications***

THE SOVIETS have formed a powerful "super agency" for research, apparently to further exploit their space accomplishments.

Set up only a few days after the USSR announced its manned spaceflight, the State Committee for Coordination of Scientific Research Work apparently will override all existing research groups and committees including the influential Soviety Academy of Sciences.

The move was interpreted by Prof. Leon Trilling, Massachusetts Institute of Technology Soviet affairs expert, as an indication that the Russians would concentrate on the potential application of their research projects—lifting applied research far above basic research.

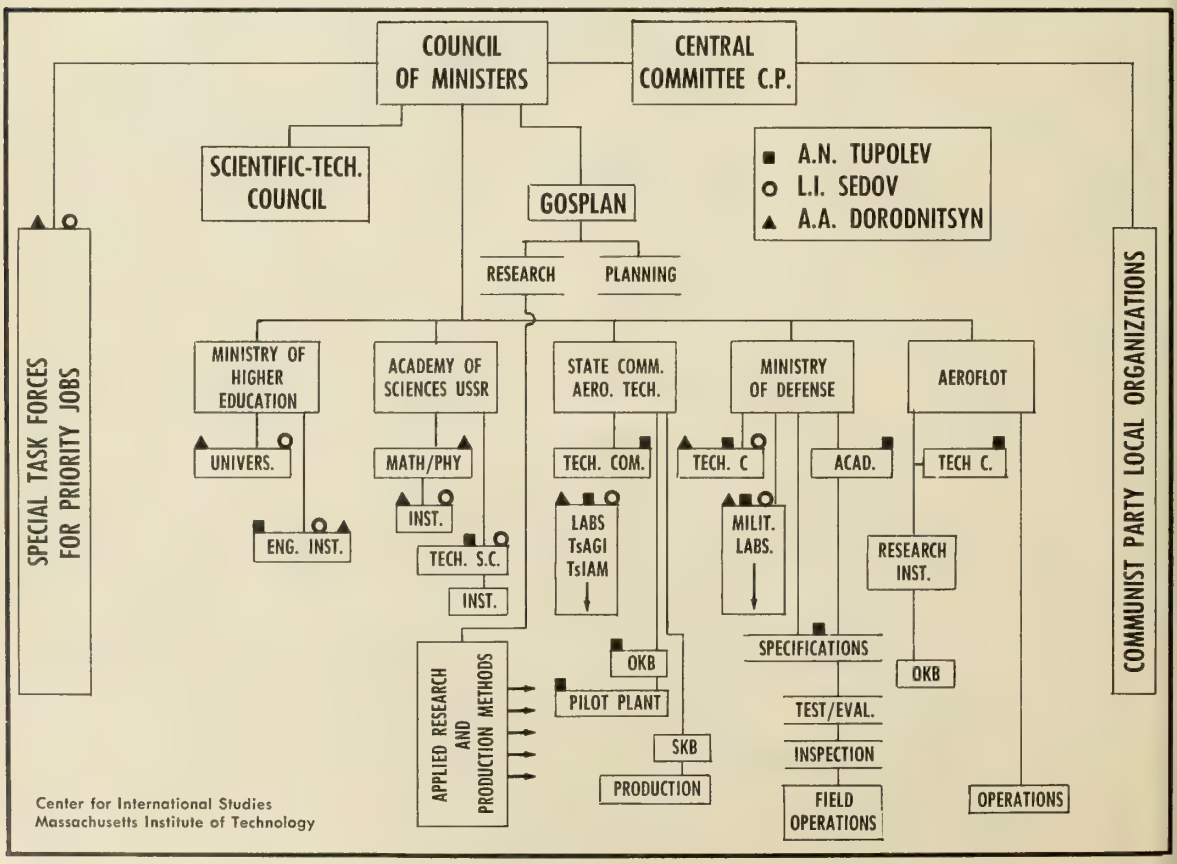
"We would not say that they are upgrading their scientific effort by this move. It gives the definite impression that they are going to push heavily to exploit their space accomplishment and the state of the art in astronautics," Prof. Trilling told M/R.

Head of the new committee is a military airframe man—not a scientist. Lt. Gen. Mikhail V. Khrunichev was head of Soviet airplane production and First Deputy Chairman of the State Planning Committee (GOSPLAN). The new committee apparently will have equal stature to the GOSPLAN and report only to the Soviet Council of Ministers (see chart).

Prof. Trilling said it probably would assimilate the Scientific-Technical Council. The Ministry of Higher Education, the Academy of Sciences, and the State Committee on Aerospace Technology and a number of technical committees will report directly to the new committee.

Recent reports from Moscow indicate that the Academy of Sciences has

**BELOW:** *Soviet Aeronautics R&D. The new super agency probably replaces Scien.-Tech. Council and overrides all others.*



# 3M MATERIALS MEMO

News of materials for the aerospace industry — selected from the 27,000 products of the 3M Company



## STOP SCRATCHING!

Sometimes a good scratch in the right spot at the right time can be quite a satisfying experience. And scratching is important in the missile world, too, in a negative sort of way. Most any significant scratch is taboo on the birds' tender skins. Careful handling alone won't avoid the problem, either. Until levitation becomes practical, the birds simply must be supported and handled during fabrication.

There is a solution, though, and a very convenient one at that. It's the new "SCOTCH" BRAND Heavy Duty Protective Tape, Y-9013. Developed by our INDUSTRIAL TAPE DIVISION, Y-9013 offers both high abrasion and penetration resistance along with weather resistance. Even 400 hours in a weatherometer fail to degrade it or interfere with its easy and clean removal. With 9013's ability to stretch up to 25% lengthwise and 30% crosswise, conformability to contoured surfaces is excellent.

This 17 mil thick tape owes most of this **abuse** resistance to its heavy rubber impregnated paper backing. Of course, the long aging adhesive complements it well by providing stain resistance and **no** adhesive transfer (even after 9 months outdoor exposure). Whether your protection problems involve metals or plastic, check the coupon at right to learn how Y-9013 can help you wrap them up.

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## EVERY OUNCE COUNTS

A few months ago we told you how the high strength/weight ratio of "Scotchply" Brand Reinforced Plastic could be used in solid propellant rocket motor cases. Let's not forget, however, that it's just as important on many small items. Take, for example, a simple thing like a machine bolt. Although weight savings may seem insignificant on a single bolt, remember that some birds are literally "buckets of bolts."



The way to make such fittings is with "Scotchply" 1100 High Strength Molding Compound. Grumman Aircraft for one has used it effectively to make machine bolts that are 20% lighter than aluminum . . . twice as strong as those made from other molding compounds. Tensile strength of the molded bolts was 22,000 psi and the double shear strength was 22,000 psi.

"Scotchply" 1100 is both an interesting and convenient material. In its uncured form, it's a series of free flowing, uncured ½" glass fibers uniformly impregnated with epoxy resin (35% by weight). Required press temperature for molding is about 330°F. Pressures for compression molding range from 250 to 2500 psi and for transfer molding, 1000 to 10,000 psi.

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been instructed to concentrate on the most promising and rapidly developing branches of sciences, such as physical and humanitarian sciences. Another move will be to speed up the gap between research and production, and the introduction of new scientific discoveries into the economy.

Other elements of the Soviet research organization were described by Prof. Trilling to the Institute of Aerospace Sciences. He listed the five guiding principles of Soviet research as:

1) Setting up of strict priorities insuring the allocation of resources and personnel to the most vital projects. While policy-makers are technically literate and alert to the potential of applied science, they do not accept extensive advice from scientists on which things should be done—only how something should be done.

2) Separate functions are maintained for research, development and production throughout the entire space program. Scientists are usually trained at universities, research engineers and designers at engineering institutes (both civilian and military), and engineers at other engineering institutes. This "packing order" was originally set up in order to concentrate scarce available teaching and design talent in a few central locations.

3) Single responsibility, though not as rigid now as it was in earlier days, is still dominant in the high-priority programs. The method selects the most capable managers, puts them into top slots in vital programs, and consequently sacrifices emphasis on other areas of endeavor.

4) Special task forces for special jobs. A corollary of the concept of single responsibility, this approach enables the top man to put together a team for which he is ultimately responsible. Since R&D is treated as in instrument of national policy, its objectives are specific and concrete.

Much research and development, says Dr. Trilling, resembles a dash runner trying to run a mile race. R&D is often programed as a sequence of short and medium range tasks for fulfilling specific immediate requirements.

5) A multiple-hat system assigning a number of concurrent administrative responsibilities to each leading scientist concentrates the management of large segments of the overall R&D effort in a small group of men (see chart).

• **Decision-making pattern**—In detailing the route which high-level decisions must travel before becoming action, Dr. Trilling pointed out:

The Communist Party of the Soviet Union (CPSU), has an administrative structure independent of the official government administration. It defines the values underlying policy decisions and its top personnel overlap the government. Its local organizations provide alternate channels of communication and command.

The Academy of Sciences has the statutory responsibility of doing the Soviet Union's basic research in its various institutes and laboratories. The Academy includes in its membership scholars, engineers, and military officers with technical backgrounds. Dr. Trilling points out that these last members have increased markedly in number in the last decade and there are now 20 technical officers of flag rank among the 31 academicians in the Department of Technical Sciences.

A particularly important triple role is played by the Zhukovskii Military Air Engineering Academy, which trains officers for the technical branch of the Soviet Air Force, giving them a five-year military engineering program. In addition, it gives a military background to designers, and almost all senior Soviet aircraft and missile designers currently active have attended the academy for at least two years, including some of whom have taken the full program and graduated (Yakovlev, Mikoyan, Gurevich, Ilyushin and others).

Its third function is that of updating in the technical fields all those field officers who appear to have special promise for future high command. As an illustration of this, the ten present ranking generals of the Soviet Air Force took a two-year course at the academy when they held the rank of major or colonel and were of age 33 to 37.

The Zhukovskii Air Academy school badge singles out and unites the entire policy-making community of the aerospace development program.

• **Program organization**—Aerospace research and development, as shown by the organizational chart, is divided among a number of permanent agencies directly responsible to the highest group of authority in the USSR, the Council of Ministers. These permanent agencies include the Academy of Sciences, the State Committee on Air Technology (formerly the Ministry of Aircraft Production) and the Ministry of Defense.

Note the multiple-hat assignments of the three key scientists, A. N. Tupolev, L. I. Sedov and A. A. Dorodnitsyn.

In addition to the three primary agencies the Ministry of Higher Education and Aeroflot, the state airline, are also on an organizational par. The Ministry of Higher Education is responsible for research done at university and engineering-school levels.

Special task forces, somewhat akin to the U.S. wartime Manhattan Project, are entrusted with overriding authority to push through vital programs.

The Interdepartmental Commission for Interplanetary Travel which was established in 1954 may be all or part of such a task force in missiles and space vehicles. It includes 27 members, of whom 14 are scientists (6 astronomers, 1 geophysicist, 2 physicists, 1 chemist, 3 theoretical aerodynamicists, 1 designer of computer systems); 9 are engineers (4 propulsion, 3 electronics and guidance, and 2 in telemetry and data reduction). In addition to these, three are generals of artillery and air forces, and another is an administrative aid.

A few of these members are drawn directly from Academy ranks, while others are designers on staffs of different ministries involved.

While the commission itself does no research, it does take part in fund allocation and its individual members supervise parts of an overall program, each member working within his own jurisdiction and in a coordinating role.

According to Dr. F. J. Krieger of the RAND Corp., it was also in 1954 that the Presidium of the Academy of Sciences established the K. E. Tsiolkovsky Gold Medal for outstanding work in interplanetary communications, to be awarded every three years beginning in 1957. Although no recipient for this medal has yet been announced, several Lenin prizes have been awarded for contributions to space projects.

The Interdepartmental Commission

## Distribution of Personnel

| | USSR | US |
|---|---|---|
| Basic and applied research | 140,000 | 60,000 |
| Development | 100,000 | 300,000 |
| Design | 170,000 | 100,000 |
| Production | 260,000 | 200,000 |

## Soviet Long-Range Space Program*

**Phase I—Earth satellites**

- *Surveillance satellites in polar orbit with optical and television equipment*
- *Space stations at high altitudes*

**Phase II—Exploration of the moon**

- *Ranges from initial three Luniks to plan for sending two manned vehicles at the same time. Supplies and fuel would be deposited on moon in advance for use by landing party during stay and for return.*

**Phase III—Interplanetary travel**

- *Reconnaissance rockets to each planet*
- *Artificial satellites of the sun*

* *Phases are concurrent*

on Interplanetary Communications joined the International Astronautical Federation in 1957.

In December, 1956, 13 Soviet scientists attended the International Congress on Rockets and Guided Missiles in Paris. Papers presented there already showed the surprising progress the Soviets had made.

• **Academy of Sciences**—Divided into eight departments, the Academy of Sciences has two specific departments of interest to the space program.

The Department of Mathematics-Physics and the Department of Technical Sciences each control a number of institutes engaged in research. An example is the Steklov Mathematical Institute whose theoretical mechanics division is under L. I. Sedov; or the computing center, which is under A. A. Dorodnitsyn.

Altogether, Dr. Trilling states, the Soviet Academy of Sciences controls—directly—about 12% of the entire USSR research and development budget.

Size and scope of the numerous academy research institutes is widely variable. At one extreme is the Institute of Automatics and Telemechanics, with a staff of more than 1000, of which 300 are scientists. This group does fundamental research on automatic control systems, data processing and related fields. It builds breadboard models of new devices, which are then passed along for development elsewhere.

At the small end of the spectrum, the Mechanics Institute has a total staff of about 200, of whom 80 are scientific personnel. A breakdown of this group shows a Solid Mechanics Department, with further reduction into sections of elasticity under Sokolovski; plasticity under Ilyushin; construction mechanics and wave propagation in solids under Rakhmatulin and a general mechanics section to handle stability of motion, theory of oscillations, gyroscopes, automatic controls, etc.

The Fluid Mechanics Department of the same institute has sections on hydrodynamics and filtration problems, high-speed gas dynamics, and rarefied gas flows. In 1958 this Institute as a whole had a modest structural lab and a "Strela" digital computing machine. Within the past two years, it has built a shock tube and a small hypersonic wind tunnel.

The research programs of these institutes, Dr. Trilling said, are formulated as broad five-year plans and also as detailed yearly plans. The plan includes a combination of problems assigned from above and of other problems generated within the institute.

It is believed the more creative staff members in these organizations are fairly free to do what they want, while the rest are assigned to specific tasks suggested by outside agencies.

• **Other research groups**—Universities also handle much basic research in the aerospace field, particularly through the Mechanics Faculty. Included in this effort are graduate theses and some sponsored research. Moscow and Leningrad Universities are especially active in this work.

Additionally, special work can be carried out by any government agency on various projects. When the photographs of the back side of the moon were completed, considerable work was required to eliminate distortions and impediments, as well as ascertain the actual formations on the lunar surface.

Dr. Krieger said the photos were processed by obtaining three copies of the negatives, which were then sent to three different scientific organizations, the Academy of Science's main astronomical Observatory at Pulkovo, the Shternberg State Astronomical Institute in Moscow and the Astronomical Observatory of Kharkov State University.

Each of these organizations studied the photos separately, and the results were compared. The more detailed processing was carried out in Moscow in collaboration with the Central Research Institute of Geodesy, Aerial Photography and Cartography.

Some basic research, and considerable applied research and development is carried on in a series of special institutes administered by the State Committee on Aircraft Technology. Other similar organizations are supported by the Ministry of Defense and the Ministry of Defense Production.

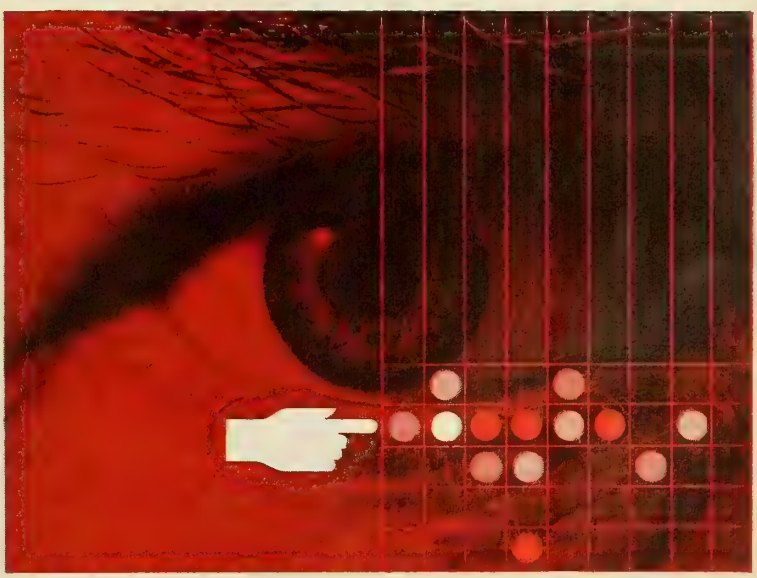
These include various large laboratory complexes such as TsAGI, TsIAM, VIAM, and LII, which form a network comparable in size and scope of activity to the research centers of NASA.

TsAGI specializes in hydrodynamics, aerodynamics, stability, control, and related fields. TsIAM specializes in propulsion. VIAM's work centers around airborne materials, fuels and lubricants. LII is the country's flight test center.

The facilities comprising these laboratories are not very well known, and Dr. Trilling points out that even less is known about the 60 or more laboratories specifically devoted to development of airborne electronics, rockets and advanced power plants.

Reliable estimates, however, place the working staffs of each of these major complexes at about 400 scientists each on the average, with supporting

*(Continued on page 48)*



THINK, ACT! How will crews of aerospace vehicles perform under long periods of stress and confinement? Lockheed/Georgia finds accurate answers in the crew mockup section of its Behavioral Research Lab – just one of the many capabilities of its highly qualified Human Factors Research Group. LOCKHEED/GEORGIA

Marietta, Georgia

# Adhesive Takes High Heat and Shock

***Space uses envisioned for cement which bonds glass, ceramics and metals and has high radiation resistance***

DEVELOPMENT problems with high-temperature thermal converters have produced a dividend in the formulation of a new high-temperature adhesive—capable of a maximum service temperature of 5300°F.

American Thermocatalytic Corp., Mineola, N.Y., discovered that no known high-temperature adhesive would meet the requirements of the radiant reactors as used in its combustion process.

A research program was initiated to find an adhesive having an extremely low coefficient of expansion and excellent bonding characteristics to ceramics, refractories, quartz and metals. It would also have to withstand continuous service temperatures over 4000°F and repeated, severe thermal shock.

The investigation resulted in a family of cements designated "Astroceram."

K. W. Cornely, ATC's chief chemist, says the coefficient of thermal expansion for the cements is $5 \times 10^{-9}$ in./°F. Their most outstanding properties are resistance to high temperatures and heat shock. The adhesives do not react nor cause reactions when in contact with metals and ceramics.

Cornely believes this special inertness is due to the formation of "saturated" compounds. Astroceram is essentially a 2 component phase system. Thus one component is saturated with regard to the second component in a ceramic sense.

• **Startling properties**—The actual composition of the cement is proprietary, but it is known that one component is based on the oxides and silicates in the Group IV elements of the Periodic Table.

Other physical properties include a thermal neutron cross-section ranging from 20 to 30 Barns and a thermal conductivity of the order of 23.2 Btu/hr. ($ft.^2$) (°F/in.).

Tests of the mechanical properties showed that Astroceram cements possess a hardness of 8-9 Mohs, tensile strengths from 10,000 to 15,000 psi and compressive strengths from 80,000 to 150,000 psi. Modulus of rupture is close to 23,000 pis and porosity between 0 and 0.2%.

The dielectric strength of the cements is 200-300 volt/mil, with dielectric constant of approximately 9.0 at 60 cps and from 7 to 9 at $10^6$ cps. Arc resistance tests resulted in a showing of over 500 seconds. Volume resistivity is $10^{13} - 10^{15}$ ohms/cm.

Chemically, the cements are soluble in hydrofluoric acid but only slowly soluble in boiling concentrated sulfuric acid. They are insoluble in hydrochloric, nitric, phosphoric and sulfuric acids at room temperature.

At temperatures over 1800°F, the cements are resistant to carbon monoxide, carbon dioxide, water, oxygen and hydrocarbons. Additional resistance to sulfur and arsenic at 1800°F has been confirmed. The adhesives react with carbon at temperatures exceeding 3000°F. Reactor work has demonstrated the excellent resistance to radiation.

• **Missile/space applications**—A number of manufacturers have been successfully using the cements in the casting of welding and brazing fixtures, and crucibles. Glass, quartz, zirconia, alumina, refractories, ceramics and metals have been bonded. Astroceram adheres so tenaciously to aluminum, says Cornely, that it is possible to melt away the metal, leaving the cement intact.



*ASTROCERAM wire withstands 3500°F exposure; uncoated Nichrome wire melts.*

The cement can be used as a dielectric for capacitors, a potting compound for electronic components, in sealing feed-through insulators and as a mortar for fire-brick in high-temperature furnaces. Fire-brick can be upgraded by a surface coating to withstand extreme temperatures.

Thermocouples have been encapsulated with Astroceram, in place of ceramic and metal sheaths, resulting in improved heat transfer. In this connection, it has been employed in wire casing and wire end seals.

Boeing, NASA, AEC, Lawrence Radiation Labs, Chance Vought and others are investigating the adhesive for a host of applications. It is being evaluated to determine its adaptability for the manufacture of nose cones.

The firm has two basic types of cement available. One can be air-dried and has a service temperature around 4300°F. The second must be fired to achieve a bond and can be used up to 5300°F.

Recent additions to these basic compound types include two low-porosity cements intended for vacuum sealing purposes. ATC chemists are currently developing dry powder mixes, pre-coats and compounds possessing higher coefficients of thermal expansion and covering a broader range of applications. ⁂

## Lockheed Researchers Find Low-Energy Neutron Source

LOW-ENERGY accelerators will produce a useful amount of neutrons through a technique developed by nuclear physicists at Lockheed's Missile and Space Division.

Previously, the only source was the more costly high-energy accelerators. The Lockheed scientists can now produce neutrons in the 8-11 million electron volt range by bombarding $C^{14}$ with deuterons accelerated in a conventional 3-million-electron-volt Van de Graaff generator.

Besides being useful as a lab source of neutrons, the $C^{14}$ deuteron stripping reaction is of interest in theoretical nuclear physics. ⁂

# British Report on Wide Range Of Research

***Universities, government agencies are cooperating in rocket, satellite, tracking experiments and basic study***

**by Anthony Vandyk**

FLORENCE, ITALY—Great Britain is experimenting in vertical sounding rockets, satellites, tracking and data recovery, and carrying on theoretical studies as part of its continuing space research program.

A progress report on the program was given at the COSPAR meeting here this month.

The general overseeing of the program's scientific content is the responsibility of the British National Committee on Space Research. This Committee reports to the Council of the Royal Society, and advises the Minister for Science through the Space Research Steering Group.

Facilities for carrying British experimental apparatus in earth satellites are being provided by the U.S. National Aeronautics and Space Administration. A start has been made in collaborative rocket experiments with both Canadian and French scientists.

Vertical sounding rockets are supplied for the program by the Ministry of Aviation, and launched in Australia by arrangement with the Australian Department of Supply.

• **Tracking and data recovery**—The British have continued active in tracking of earth satellites and space probes. At the Nuffield Radio Astronomy Laboratories, Jodrell Bank, the 250-ft. radio telescope equipment has been used, in cooperation with NASA, to track the *Pioneer* series of space probes.

Radio tracking of satellites using interferometer systems is carried out by the Radio Research Station, Slough. With the help of NASA, a Minitrack station has been installed at the station and is now an operational part of the worldwide chain. The British Broadcasting Corporation continues to record telemetry signals and other features of the radio transmissions from a few chosen earth satellites.

The need for optical tracking of high accuracy is widely recognized, the British report says, but is difficult to meet in the English climate. An attempt to avoid this limitation has been made by installing optical tracking stations at the Royal Observatory, Edinburgh, and on the island of Malta, where the station is controlled by the British Meteorological Office.

One of the recognized shortcomings of present-day precision optical tracking equipment is that it is expensive both to make and to operate, or has severe limitations in accuracy and sensitivity. A number of groups in the U.K. are working towards designs which promise to overcome these difficulties.

Amongst the techniques being developed are a photo-electric method at University College, London, and the use of image intensifiers at Imperial College, London. It is hoped in this latter method to take advantage of the much greater quantum efficiency of photo-cathodes compared with the human eye and photographic emulsions. Other developments in optical tracking equipment include work at the Royal Radar Establishment on Schmidt cameras, and at the University College of Wales on other forms of special cameras.

• **Scientific experiments**—Experiments recently carried out, or in an advanced stage of planning, cover a wide range of interests, and are listed below under subject headings.

• **Atmospheric structure and composition**—The atmospheric temperature, pressure, density and winds up to 55 miles altitude are being investigated with the rocket grenade method. At regular intervals grenades are ejected normal to the rocket trajectory to explode some distance away. Recently, considerable use has been made of the luminous glows that follow the grenade bursts above 60 miles, persisting for many minutes. It is likely that the glow is a photo-chemical effect arising from reaction with atomic oxygen. The changing shape and size of the glow makes it possible to estimate diffusion coefficients and local wind velocities.

It is planned to extend the altitude at which density determinations from rockets are made by tracking a light balloon ejected from the rocket. Wind and temperature measurements using the grenade method will be extended so that a systematic study of diurnal and seasonal variations become possible. This part of the scientific program is largely the responsibility of University College, London, and the British Meteorological Office.

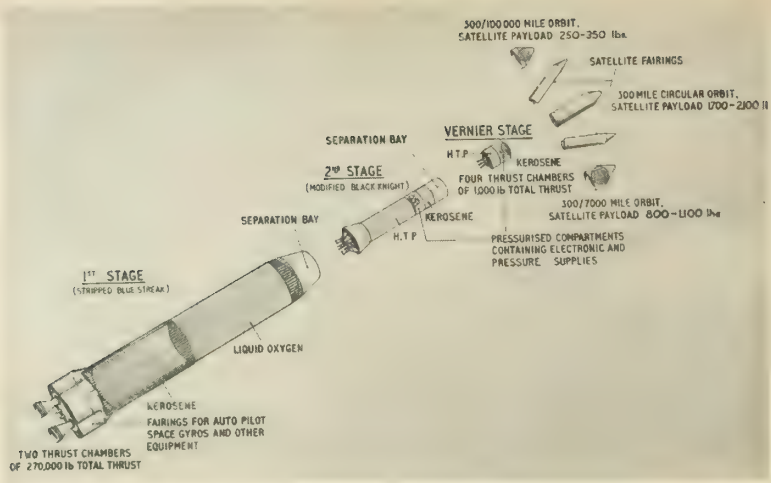
Independent measurements of temperature, winds and diffusion rates are made by a group from the University of Belfast, using the technique of sodium ejection from rockets. Photographs of interference fringes have been obtained from sodium trails with a Fabry-Perot interferometer.

The Belfast group are also studying airglow characteristics and plan to measure the heights of the airglow by carrying, in *Skylark* rockets, photometers sensitive to various airglow radiations.

A substantial part of the British effort concerns the electrical state of the atmosphere and its relation to the radiations believed to be mainly responsible for the ionosphere. Experimental measurements of electron density using a Langmuir probe type of technique (University College, London) and of electron density using a dielectric measurement type of technique (University of Birmingham) have been made from *Skylarks*. Observations on the positive ion content of the ionosphere have been made with rockets by the same two groups, using a Langmuir type probe and a time-of-flight mass spectrometer respectively. It has been confirmed that $NO^+$ is a dominant ion.

A logical extension from this rocket-borne set of experiments to satellite-borne experiments has been made possible by the cooperation of NASA, which is providing a *Scout* satellite (International Ionosphere Satellite *S-51*) for the British program. It is planned to use this satellite to measure electron density by the two methods mentioned above, as well as to measure electron temperature and the positive ion temperature and mass spectrum. At the same time, measurements of solar radiation in the 3-13 Å X-ray band and around the 1216 Å ultraviolet band will be made.

Analytical studies are in progress both at the Royal Aircraft Establishment and at University College, London, on the determination of air den-




## *European Space Rocket Proposal*

*RECENT DESIGN proposed by British for adoption by members of the Western European "Space Club." It would use a stripped-down Blue Streak as first stage, and a modified Black Knight as second stage. France earlier offered to make second stage.*

sity from satellite orbits, and on the large variations of air density under various conditions. For instance, the great differences in air density between day and night at 300-450 miles have been investigated in detail, and the decrease in density since the sunspot maximum of 1957-58 has been traced.

The Department of Meteorology of Imperial College, London, are studying upper-atmosphere winds by obtaining radar tracking observations of bundles of resonant dipoles ("windows") released from *Skylark* rockets in Australia. Observations have been obtained in the altitude band from 20 to 40 miles.

The Meteorological Office plans to use small rockets launched from sites in the British Isles to raise the present radio-sonde ceiling of about 20 to 40 miles in the first place, and later to 60 miles.

The Meteorological Office are also planning to examine the vertical distribution of ozone in the atmosphere by measuring the absorption of solar radiation across the Huggins band. A rocket-borne experiment is to be flown shortly in Australia, and it is hoped to mount a similar experiment in a suitable satellite.

Finally, radiation studies of the atmosphere are made from a theoretical and experimental point of view, at Imperial College.

• **Radio propagation and the Ionosphere**—The ionosphere is being studied through methods involving radio propagation observations from both rockets and satellites. The University of Wales, with the Royal Aircraft Establishment, have successfully carried out C.W. Doppler experiments using a *Skylark*, and plans are proceeding for a pulse radio propagation experiment.

The Radio Research Station and the University of Sheffield are undertaking an experiment in which the nature of the wave field set up above a long-wave transmitter (200 kc/s) is explored by means of apparatus in a rocket. Deductions will be made about the electron distribution in the D region.

At the University of Manchester, Jodrell Bank, ionospheric studies have been carried out by observations of the transmissions from several satellites. In particular, during most of 1960, the 108 Mc/s radiation from *Vanguard I* was examined for Faraday rotation. Irregularities of several percent in the total ionization, with a size of several hundred kilometers, have been revealed. A joint study with several other European stations of scintillations in the transmissions from *Sputnik III* has also been made.

An Admiralty station has obtained extensive recordings of the frequencies of signals received simultaneously from *Sputnik III* at three widely separated stations. Analysis of this data is expected to yield ionospheric information of great interest.

• **Geomagnetism**—In the Geophysics Department of Imperial College, London, possible techniques for exploring the geomagnetic field from rockets and satellites are being studied. It is planned to perform experiments using *Skylark* to carry a proton precession magnetometer.

• **Geodesy**—At the Royal Aircraft Establishment, satellite orbital theory has been extended in two ways. First, a theory has been developed which provides analytical expressions for the effect of aerodynamic forces on orbits in an oblate rotating atmosphere. Second, a fuller theory for the effect of solar and lunar perturbations, including solar radiation pressure, has been formulated.

These, and earlier theories, have been applied to actual orbits to determine the earth's gravitational field. New and better values have been obtained for the coefficients of the second, fourth and sixth harmonics in the earth's gravitational potential.

• **Micrometeorite studies**—The Queen's University of Belfast are making micrometeorite studies by using the microphone detector type of equipment in *Skylark*. These operate successfully in flight and impact records have been obtained.

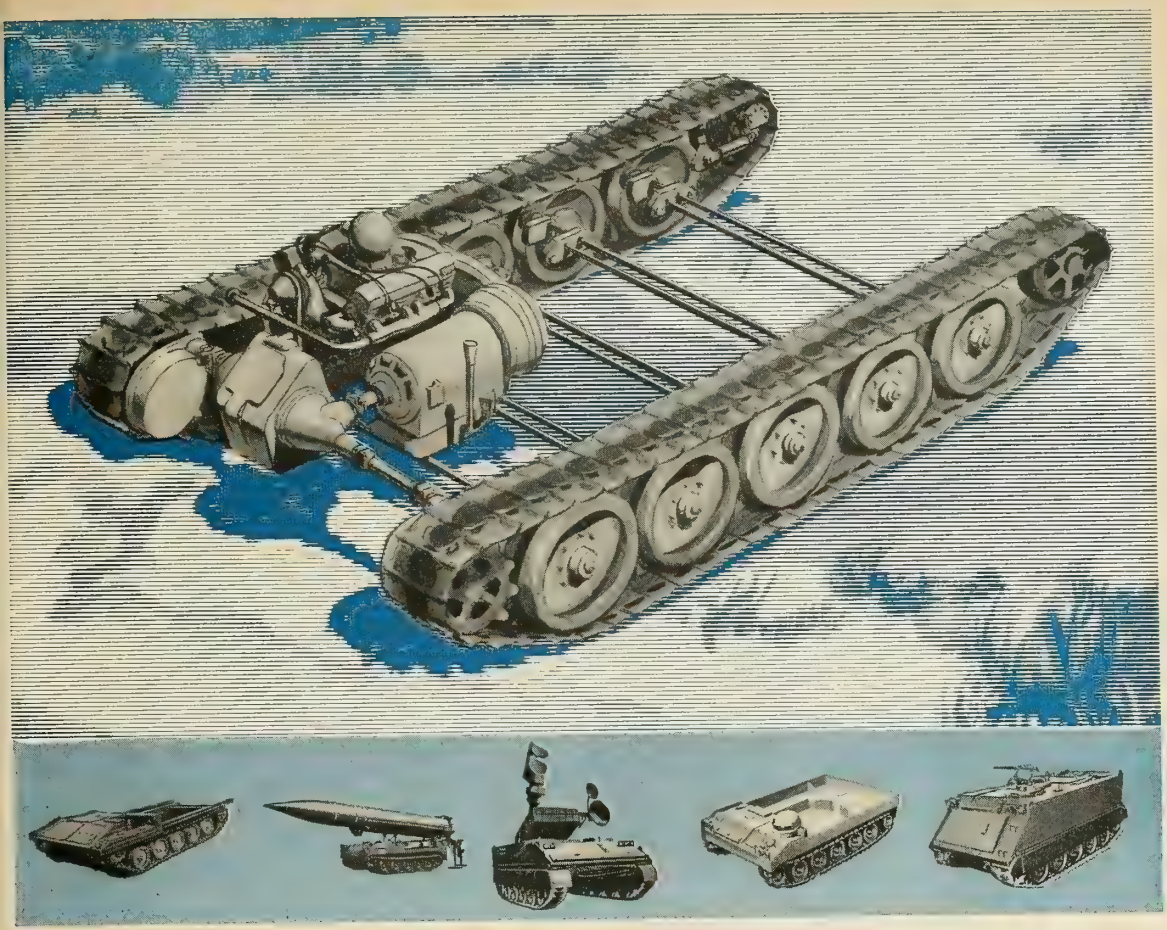
Micrometeorite studies using a different instrument technique are in progress at the Jodrell Bank Station of Manchester University; *Skylark* rockets are to carry the detectors, consisting of thin aluminum foils in which holes are formed by impacting particles. The holes are scanned by sunlight, and the transmitted light pulses are detected by silicon cells. Calibration holes allow an estimate of micrometeorite size.

• **Cosmic radiation**—In the Physics Department of Imperial College, London, investigations of the relationships between the cosmic ray intensity, solar activity and the structure of the interplanetary magnetic field are continuing. Further theoretical work has been carried out on the behaviour of primary cosmic rays in the geomagnetic field and scale-model experiments are in progress to determine the effects of various field configurations, of both internal and external origin, on cosmic ray threshold rigidities.

The first *Scout* satellite carrying U.K. instruments (International Ionosphere Satellite *S-51*) includes a cosmic ray detector of Imperial College. This detector is intended to have an operational test soon in a high-altitude research rocket in Australia.

At the University of Southampton, it is proposed to develop equipment for rocket and satellite experiments in which the higher energy components of primary cosmic rays will be studied.

• **Electromagnetic radiations and astronomy**—At the Mullard Radio Astronomy Observatory, University of Cambridge, an experiment and suitable equipment are being designed to extend measurements of the spectrum of the radio emission from the galaxy down to frequencies of about 1 Mc/s. The receiver, with a long wire dipole aerial, will be suitable for installation in a satellite. ⌗



# STANDARDIZATION CUTS R & D COSTS AND REDUCES MILITARY LOGISTIC BURDEN

Food Machinery and Chemical Corporation, working closely with the Ordnance Tank Automotive Command and the using forces, has put the standardization idea to work.

A prime example is the modern Army's multipurpose vehicle family. Based on the M113, an entire family of vehicles ranging from armored personnel carriers to unarmored missile carriers has been developed that uses the same engine, power train and suspension as interchangeable components. This standardization saves research and development dollars, adds production economy, and eases logistic problems in field operation.

Take advantage of these cost saving factors in planning your mobile GSE equipment. Call in FMC engineers at the concept stage of your project.

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1105 COLEMAN AVENUE, SAN JOSE, CALIF.

## Canada's 'Longlegs'

(Continued from page 18)

by Canada's National Research Council to investigate cosmic particles and related phenomena.

A beacon transmitter is being built into *Longlegs* for tracking and fixing its location in space.

A command receiver will conserve power by activating the sounder for 12 min. only while over a ground telemetry station. Four nickel cadmium batteries, rechargeable by solar cells, provide the power.

DRTE's *Longlegs* will sound the ionosphere directly below it each time it is activated. Secondary experiments will measure cosmic radio noise intensity and particle energy of cosmic rays.

• **Not competitive**—Comparison of the sounding-at-distance and sampling-the-immediate-environment techniques should provide an exact measure of the free electron density which can be compared with results obtained by other ionosphere sampling (e.g. satellites of *Explorer VIII* class).

This is precisely the information gap which the U.S.-Canada experiment will fill. Both types of measurement need to be made simultaneously for an extended period, however, before enough is understood about the upper atmosphere.

Policy guidelines attributed to NASA, which sponsors both types of satellite research, are said to assure complementary and not competitive experiments.

The Canadian satellite will gather needed information on radio waves which do not penetrate the dense layer of the ionosphere and, as a result, provide no information to the scientists on the ground.

Soundings obtained when the satellite passes the northern auroral zone will be particularly interesting to Canada because of the special communications problems existing in high latitudes and Arctic regions during auroral disturbances. ⌘

## British-NASA Probe Set

***A second British satellite will be launched in 1963 by a U.S.* Scout *vehicle.***

***Scientists from Britain and the U.S. National Aeronautics and Space Administration announced agreement last week on plans for a spacecraft that will measure galactic radio emissions at wavelengths too long to penetrate the earth's atmosphere.***

***The satellite will also carry instruments to measure vertical distribution of ozone in regions where it is being formed, measure micrometeorite size and number and obtain data on the electrical condition of the upper atmosphere.***

***It will have an apogee of about 1200 miles and a perigee of 180 miles.***

***The first British Scout satellite, to be launched in 1962, will be designed for ionosphere measurements.***

## Space Crash Program?

(Continued from page 16)

questioning that the biggest cut was about $50 million for Project *Apollo*—$42.6 million of research and development money, $5 million for a tracking station and $2½ to 3 million in salaries and expenses for hiring an additional 300 in-house staff for *Apollo* at Space Task Group, Langley Field, Va. STG now has a staff of about 75 working on *Apollo*.

The next biggest cut that emerged from discussions in the Space Committee and the Joint Atomic Energy Committee was $30.5 million from Project *Rover*. The *Rover* cut broke down to $7 million in Atomic Energy Commission operating funds, $8.5 million in NASA R&D money and $15 million of NASA construction money.

At the same time the Joint Committee disclosed that the Kennedy administration has suspended plans for flight test of the *Rover* nuclear rocket pending a new study of the program by a committee chosen by Dr. Jerome Wiesner, Kennedy's chief scientific adviser. However, the review does not interfere with the administration's previously approved relatively modest speed-up of the *Rover* R&D program.

NASA officials outlined for the Space Committee these other items disallowed in the Kennedy review.

—Lunar & planetary programs, $25 million additional for *Mariner B*, a preparatory shot in 1963 designed to test out equipment for a 1964 Mars probe.

—Scientific satellites, $13 million to increase contractor funding on the Orbiting Astronomical Observatory and the Orbiting Geophysical Observatory to make certain that flight target dates are met.

—Meteorological satellites—$12 million for two additional *Tiros* satellites, to make certain that a weather satellite is in orbit all the time until the *Nimbus* satellites are ready to fly.

—Life science programs, $5 million for contract research.

—Support of NASA plant, $4 million.

Altogether, NASA sought $236.49 million additional for R&D, $52.2 million for construction of facilities and $19.5 for salaries and expenses, for a total of $308,191,000, Seamans said.

The additional *Apollo* R&D money would be used for high-speed re-entry tests with *Atlas-Agena B* vehicles and to give the R&D contractor a start earlier in the fiscal year. Under the previously allowed $29 million for *Apollo*, the contract would not be awarded until after the first of the year.

The $5 million tracking station would be added to the *Mercury* network to give the net the capacity for tracking during more than three orbits and would permit long *Mercury* shots in preparation for *Apollo*.

On Project *Rover*, the $15 million construction item would have been for a nuclear rocket testing facility in Nevada. The $7 million for the AEC would have speeded reactor development. The NASA R&D money would expand work performed under the Nerva engine contract, to be awarded in the next month or so.

Rep. Melvin Price (D-Ill), chairman of the R&D subcommittee of the Joint Committee, said that unless the full requests are allowed for *Rover*, it will be impossible to meet the previously announced launching date in 1966-67.

Meanwhile, a committee headed by Harvey Brooks of Harvard University conducted the *Rover* study for Wiesner. Other members of the committee are: Al Donovan, Aerospace Corp.; Arthur Biehl, Mainhardt-Biehl Associates; Eugene Wigner, Princeton University; William Graham, Rand Corp.; Theodore Merkle, Livermore Laboratory; Stanislaus Ulam, Los Alamos Laboratory; Walter Zinn, Combustion Engineering; and Berndt Matthias, Bell Laboratories.

Other construction requests disallowed by Kennedy, Seamans said, included $17 million for a high-vacuum facility to test new types of propulsion at the Lewis Laboratory in Cleveland and a test stand for the *F-1* liquid rocket at Edwards AFB. ⌘

## 'Meteor Bumper' Proposed To Shield Space Vehicles

PALM SPRINGS, CALIF.—General Electric engineers report that using a thin outer shield to protect space vehicles against both natural and man-made meteoroids would make it possible to cut the weight of external wall structure by more than half—with no sacrifice in safety.

Robert R. Wallace, J. R. Vinson and Murray Kornhauser of General Electric's Missile and Space Vehicle Department reported on investigation of the "Meteor Bumper" concept at the American Rocket Society Conference on Lifting Re-entry Vehicles.

# FREQ. STDS.

## AND TUNING FORK OSCILLATORS

TYPE 10, ACTUAL SIZE



SIZE, 1-3/8" x 1-3/8" x 3/8"

**This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.**



TYPE 2007



TYPE 15

For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

### TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

### TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

### TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2⁹⁄₁₆"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

### TYPE 15 FREQUENCY STANDARD

Similar to Type 10 (illustrated) except with silicon transistor, hermetically sealed and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from —40°C to + 71°C
Output: .IV at 50,000 ohms source impedance.

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CLOSING DATE MAY 8
Materials
Boosters
Electronics
Space Medicine
Re-entry

# contracts

## NASA

**United Controls Corp.**, Seattle, from **Lockheed's Missiles and Space Division**, for a programing device to provide the electrical impulse to restart the *Agena* satellite engines. Amount not disclosed.

**ITT Federal Laboratories**, Fort Wayne, Ind., for design and fabrication of a portion of space-borne weather reconnaissance equipment for *Nimbus* satellite program. Amount not disclosed.

## MISCELLANEOUS

$82,000—**Dunn Engineering Corp.**, Cambridge, Mass., from **Lockheed Aircraft Corp.**, for manufacture of system for testing missile and satellite inertial guidance assemblies and their components.

## NAVY

$3,227,400—**Sperry Rand Corp.** through **Sperry Piedmont Co.**, Charlottesville, Va., for HK 19 MOD 3A gyro compass equipment.

$2,000,000—**Hycon Manufacturing Co.**, Monrovia, Calif., for automatic test equipment for *Terrier* and *Tartar* missiles.

$1,438,058—**Hickok Electrical Instrument Co.**, Cleveland, for AN/USM-105A oscilloscopes.

$318,346—**Skagit Steel & Iron Works**, Sedro-Woolley, Wash., for missile handling equipment for underway replenishment consisting of structure, machinery and controls.

$171,487—**Ramo-Wooldridge Division of Thompson-Ramo-Wooldridge, Inc.**, Canoga Park, Calif., for design, development, construction and furnishing of one set of digital equipment for use on AN/SLQ-11 passive ranging system.

**Erie Pacific Division of Erie Resistor Corp.**, Hawthorne, Calif., from **Nortronics Division of Northrop Corp.**, for a high-speed, pre-set electronic counter/timer for use in the *Polaris* missile checkout system. Amount not disclosed.

**The Garrett Corporation's AiResearch Industrial Division**, Los Angeles, follow-on order for high-pressure reducing valves for nine future *Polaris* submarines. Amount not disclosed.

## ARMY

$17,656,015—**Bowen-McLaughlin-York, Inc.**, York, Pa., for recovery vehicle, M88, and repair parts.

$1,025,000—**Rohm and Haas Co.**, Philadelphia, for research in the field of solid propellants for rocketry at Redstone Arsenal.

$118,503—**National Electric Division**, Ambridge, Pa., for rocket motor case and nozzle assembly.

$86,789—**Radiation, Inc.**, Melbourne, Fla., for services and materials required for acceleration of *Courier* program.

$37,589—**Malaker Laboratories, Inc.**, Mountainside, N.J., for R&D covering a kinetic study of rocket exhaust gases.

**Dresser Electronics, SIE Division**, Houston, for feasibility studies of using seismic technologies to determine the position of missile impact locations. Amount not disclosed.

## AIR FORCE

$11,600,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Genie* air-to-air missiles.

$4,000,000—**Marquardt Corp.**, Van Nuys, Calif., for development of a nuclear ramjet engine, Project *Pluto*.

$1,300,000—**Electronic Communications, Inc.**, St. Petersburg, Fla., from **Burroughs Corp.**, for aerospace ground equipment to be used in ALRI, the airborne extension for *Sage*.

$385,000—**Digital Equipment Corp.**, Maynard, Mass., to design, construct and install a dynamic system simulator.

$149,977—**Aerojet-General Corp.**, Azusa, Calif., for investigation of mechanism of decomposition, combustion and detonation of solids.

$146,084—**University of California**, Berkeley, for research on "Theory of Solids."

$128,325—**Aero-Space Division of Boeing Airplane Co.**, Seattle, for technical data applicable to the *Bomarc* missile. (Two contracts.)

$95,502—**University of Illinois**, Urbana, for research on solid-state phase transformations.

$75,000—**The Bendix Corp.**, Detroit, from **Boeing Airplane Co.**, for nose gear for *Dyna-Soar*.

$73,250—**Calif. Institute of Technology**, Pasadena, for continuation of "Studies of Stellar Compositions and Related Nuclear Processes."

$58,840—**Stevens Institute of Technology**, Hoboken, N.J., for research on "Mechanism and Dynamics of Conical Coaxial Plasma Acceleration."

$53,545—**General Electric Co., Missile and Space Vehicle Dept.**, Philadelphia, for research on "Fundamentals of MHD Flow."

**Warner Lewis Co., Division of Fram Corp.**, Tulsa, Okla., from **Convair Astronautics Division of General Dynamics**, for eight ground support fuel systems for the *COPS-1 Atlas* missile. Amount not disclosed.

**Defense Products Division of Fairchild Camera and Instrument Corp.**, Syosset, N.Y., for study of advanced photographic imaging techniques. Amount not disclosed.


# ALL ABOUT WELDED DIAPHRAGM

METAL Bellows

As a useful service to industry, Metal Bellows Corp. has published two compact printed pieces on the specialized subject of welded metal diaphragm bellows. This literature represents functional definitions of welded metal bellows . . . practical descriptions of uses for these bellows.

From its position as a pioneer in the design and manufacture of welded metal bellows, Metal Bellows Corp. now offers this new, fully illustrated literature.




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Circle No. 13 on Subscriber Service Card

## Propogation Study

(Continued from page 25)

The Telecommunications Planning Committee of the Office of Civil and Defense Mobilization recently reported that there is "inadequate" knowledge of some of the more technical factors affecting ultimate capacities, limitations, and spectrum utilization of space telecommunications. The report cited the need for basic advances in such areas as antenna design, modulation theory, component reliability and propagation effects to develop the potential of space telecommunications.

A recent staff report prepared for the Senate Committee on Aeronautics and Space Sciences said that the potential of satellite communications cannot be properly or adequately exploited until more basic propagation information is obtained and interpreted.

In support of the fund request, NBS cites the dependence of NASA, DOD, FCC, and others on the Bureau for basic technical information on radio propagation. Several satellite telecommunications projects—such as *Advent, Courier, Czar, Echo, Transit*—are being undertaken at present. None of these, however, is directed at obtaining the sort of basic information many scientists feel is needed. As the OCDM panel report said, much of the present effort seems aimed at "trying packages" for satellite radio transmission. "Systems do not depart radically from conventional techniques." ⌗

## Launching Drydock

(Continued from page 27)

tion can be reworked to form a communications center, test laboratories and an electronics repair shop.

• **Big enough for a carrier**—For a *Saturn* facility, 1.5 million lb. of thrust and over, the set-up begins to get more complex. Here, the basic unit is a drydock known as an "AFDB." Actually, it's only a drydock section, 250 feet long and able to support 10,000 tons. When a sufficient number of these sections are joined together, they can lift an aircraft carrier out of the water.

These drydocks were built during World War II. A considerable number of them are still in excellent condition.

Norman G. Peil, Pacific Missile Range engineer, points out that each AFDB section has diesel a-c power-generating equipment rated at 750 kva, fresh water evaporators of 200 gph capacity, ballast pumping and control systems, shops and crew facilities. In addition, each AFDB can operate while submerged. Seven AFDB's welded together form a self-sufficient ship-drydocking unit.

For a *Saturn*-type launch, three AFDB sections are proposed—one for the launch platform, another as a service unit, and a third as a blockhouse. An ARD may be used for space vehicle transport and assembly.

Other support vessels include two tugs and also ships for range instrumentation and booster recovery. Existing instrumentation ships can be used downrange for tracking, telemetry and other purposes.

Stevens estimates that it would take about 18 months after the go-ahead to have a mobile launch complex on site and ready for a check-out launch. This is comparable to the time it takes to build a similar facility on land, provided land were available and stateside. Nevertheless, it is a far shorter time and also much less costly than setting up a base on foreign soil. In addition, the political and health hazards are significantly lessened. ⌗

## Soviet Research

(Continued from page 39)

staffs numbering about 1200 to 1500 each. Some basic research is conducted in these facilities, usually in cooperation with university or academy-institute projects.

Development and testing of components and prototypes, service testing, backup consulting functions for design teams and operation of a pilot plant are also often under the jurisdiction of such groups.

Altogether, these laboratories account for approximately half the total Soviet R&D budget.

• **Hardware design**—Development and design of specific prototypes is usually handed over to advanced design bureaus (OKB) which are generally named after the senior designer, such as Tupolev's OKB, Yakovlev's OKB, and so on.

Dr. Trilling estimates that a major OKB is comparable in most respects to the design engineering staff of a major U.S. airframe manufacturer. An OKB includes from 600 to 1000 graduate engineers organized along specialty lines such as aerodynamics, structures, dynamic loads, and also along project lines.

In every known case, the OKB is adjacent to a pilot plant where the test prototype is built. Until recently, top-flight design talent being quite scarce, a policy of assigning single projects to single design groups, limiting competition and standardizing solutions of technical problems was in effect throughout the USSR.

• **Soviet space program:** Dr. Krieger quoted Soviet publications on the space program (see box). In addition, he listed certain hardware developments which the Soviets are known to be pushing:

—Creation of large boosters

—Improved stabilization and control systems, and ground launch facilities

—Perfection of high-resolution, multi-channel telemetry for multi-million-mile distances

—Broad development of space medicine.

Most secretive parts of the Soviet space program are the propulsion and guidance systems and techniques. It is these two fields in which they have had the most outstanding successes.

Dr. Krieger also credited the Soviets with apparent superiority in complex automatic control systems:

"The tendency to overengineer a system and the consequent increase in its unreliability have plagued and embarrassed American rocket and missile experts again and again," he said. "The Soviets on the other hand, by stressing fundamental principles and simplicity in design, have apparently developed the happy faculty of making proper executive decisions in the manufacture or use of computer-based control systems and determining which of several automatic control concepts is best."

In a less discouraging light, Dr. Ernest Mayer, Associate Director of Science, National Engineering Science Co., disclosed that Soviet research into the problem of combustion instability doesn't seem any more successful in producing better rocket engines from this standpoint than American research. ⌗

## Canoga Electronics Starts Advanced Studies Program

VAN NUYS, CALIF.—Canoga Electronics Corp. has set in motion a program of company-funded research projects to meet future needs for advanced electronics systems.

Designated CAP (for Canoga Advanced Programs), the effort will be directed at developing deep-space tracking, radio astronomy and ballistic missile defense systems.

George H. Nibbe, Canoga's president, said the firm prefers the company-funded approach to the prospect of waiting for "panic-button" programs to come along. He said Canoga will spend its own money to evaluate needs, feasibility, and even—in some cases—physical development.

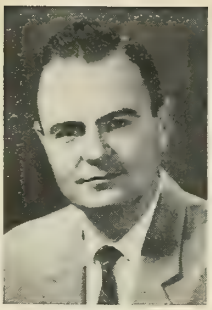
Formerly a division of Underwood Corp., Canoga Electronics is now independent. Of its total work force of 175, one-third are engineers. The firm has a division at Fort Walton Beach, Fla. ⌗

# names in the news


RUDE


HALL


LOMBARD


RICHARDSON


ANSOFF

**Arthur H. Rude:** Elected chairman of board of Aerojet-General Corp., Azusa, Calif. Other corporate appointments are: **W. E. Zisch,** executive vice president, and **Howard P. Mason,** assistant secretary. **Dan A. Kimball,** president, and all other officers of the company were re-elected.

**Willison K. Vance** and **Burl H. Ervin:** Promoted to director of applications engineering and chief engineer for systems support, respectively, of Nortronics Division of Northrop Corp., Anaheim, Calif. **E. Forrest Nance** named Western regional director of marketing, and **James B. Meagher** as marketing manager of the marine equipment department.

**Homer S. Myers:** Elected executive president of Tracerlab, Waltham, Mass., and will continue as general manager of marketing. Myers was one of the group who founded Tracerlab in 1946.

**Jack Kuhner:** Named vice president in charge of administration, and **H. Edward White** named director of industrial relations of Hoffman Electronics Corp., Los Angeles. Other appointments are: **Capt. Will I. Bull (USN, Ret.)** general manager of the Military Products Division; **Marvin G. Whitney,** director of operations for the Semiconductor Division; and **Theodore S. Hoffman,** director of operations for Semiconductor Division at Evanston, Ill. Hoffman continues as vice president.

**John S. Hall:** Joins Kidde Aero-Space Division, Walter Kidde & Co., Inc., Belleville, N.J., as manager of manufacturing and procurement. Previously Hall was manager of manufacturing at Gabriel Electronics Division, Millis, Mass.

**M. E. Mohr:** Vice president of Thompson Ramo Wooldridge, Inc., Canoga Park, Calif., appointed general manager of new Electronic Systems and Engineering group, with **W. M. Jones,** also vice president, as associate general manager.

**Maurice Stillwell:** Appointed manager, equipment plant, MicroSemiconductor Corp., Culver City, Calif. Prior to joining MicroSemiconductor, Stillwell was reliability equipment manager for Pacific Semiconductor's *Minuteman* program.

**Dr. Peter I. Pollak:** Former manager of electronic chemicals, promoted to director of the electronic chemicals research department of the Merck Sharp & Dohme Research Laboratories, a division of Merck & Co., Inc., Rahway, N.J. Other Merck researchers named to the new department are: **Dr. Walter C. Benzing,** manager of process engineering and metallurgy; **John E. Allegretti,** semiconductor technology, **Dr. John B. Conn,** thermoelectrics; and **Dr. William J. McAleer,** semiconductor chemistry.

**Edward P. Tagge:** General auditor for Beckman Instruments, Inc., Fullerton, Calif., named assistant to the president.

**Erich A. Herold:** Appointed manager of manufacturing planning at Sanders Associates, Inc., Nashua, N.H. Herold was formerly assistant factory manager with Republic Aviation, Farmingdale, N.Y.

**Raymond F. Jacque:** Former assistant manager of quality control, named manager of quality assurance in the Military Products Division of General Dynamics/Electronics, Rochester, N.Y.

**J. M. Gardiner:** Appointed assistant to the president of Thiokol Chemical Corp., Bristol, Pa. **R. E. Davis** succeeds Gardiner as head of Washington, D.C., office; **D. R. Thielen** named manager of Dayton Division office.

**Ernest W. Powers:** Named director of plans and promotion; **Leslie C. Mackrill** named senior research engineer; and **Michael M. Marks** named senior technical adviser of Frederick Research Corp., Wheaton, Md.

**Grayson Merrill:** Former manager of Astrionics Division of Fairchild Engine and Airplane Corp., joins Harris-Intertype Corp., Cleveland, as vice president-electronics.

**Dr. Donald B. Brick:** Named manager of information processing group at the Applied Research Laboratory of Sylvania Electronic Systems, Waltham, Mass. With Sylvania since 1955, Dr. Brick was formerly a research fellow at Harvard University.

**Dr. H. Igor Ansoff:** Vice president of Lockheed Electronics Co., appointed general manager of the company's Information Technology Division, Metuchen, N.J.

**Lt. Col. John R. F. Bond** and **Lt. Col. Stanley L. Nyhan:** Appointed executive officer and assistant for personnel, respectively, of Redstone Arsenal.

**Dr. Charles F. Lombard:** Leading authority on protective equipment for vital stress areas of the human body, joins Northrop Corp.'s Advanced Research Center, Hawthorne, Calif.

**Dr. J. Richard Hechtel:** Joins Research Laboratory of Litton Industries Electron Tube Division, San Carlos, Calif., as senior scientist. He was formerly head of the microwave tube branch, Naval Ordnance Test Station, China Lake, Calif.

**William K. Fortman:** Named director of research for the newly-created Astrosonic Development Laboratories of Astrosonics, Inc., Syosset, L.I., N.Y.

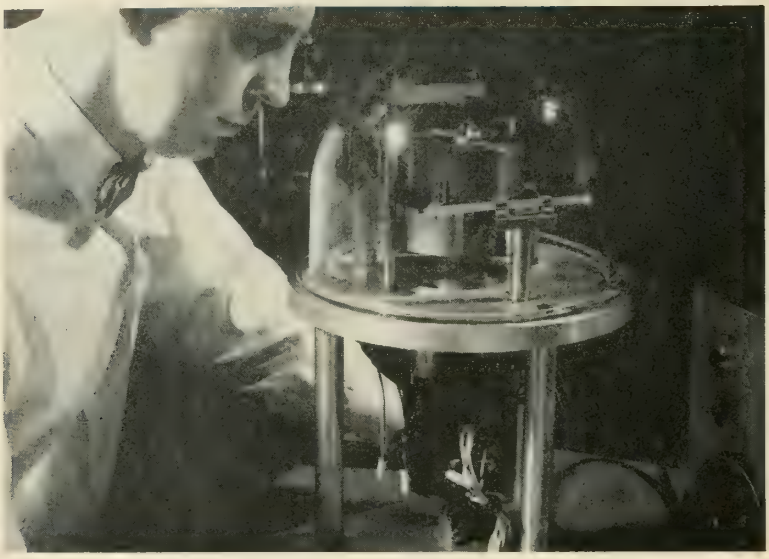
**Dr. Z. I. Slawsky:** Appointed chief of the Physics Research Department at Naval Ordnance Laboratory, White Oak, Md., succeeding **Dr. S. J. Raff,** now with the Bureau of Naval Weapons, Washington, D.C.

**Robert B. Anderson:** Joins Brown Engineering Co., Huntsville, Ala., as vice president of customer relations. Earlier he was Huntsville representative with the Autonetics Div. of North Amer. Aviation.

**Dr. Konstantin Pestrecov:** Internationally-known optical scientist and chief of Northrop's Nortronics Division Optical System Group, named a winner of the Talbert Abrams Award for his advanced work in photogrammetry.

**Lawrence B. Richardson, Jr.:** Former advanced projects engineer for Chance Vought Aeronautics, named director of marketing for Fairchild Aircraft and Missiles Division, Hagerstown, Md.

**John E. Holt:** Appointed assistant to the vice president-operations, production, of Crucible Steel Co. of America, Pittsburgh.



## Ball Bearing Simulator

Development of a research tool by the Sperry Gyroscope Co. will assure speedier and less costly advances in the design and performance of ball bearings.

The ball bearing simulator can precisely reproduce the major characteristics of these critical friction-easing devices simply and cheaply. Sperry has been able to simulate bearing life tests in only one-tenth the time required for a normal run-to-failure checkout.

The device is able to duplicate the performance of any high speed, high temperature, low lubricant bearing, such as those employed in miniaturized gyroscopes, motors or computer memory drums for missiles or space vehicles.

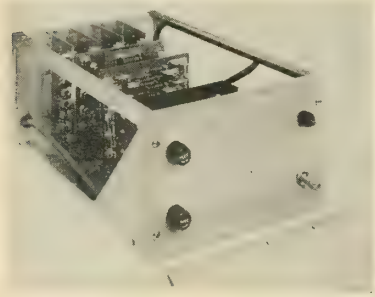
The machine, a table-top device enclosed under a sealed glass cover, exactly simulates such bearing characteristics as operating temperature, atmosphere, ball-to-race contact pressure and surface speed, roll-to-spin ratio and amount and type of ball lubricant.

Circle No. 225 on Subscriber Service Card

## Antenna Multicoupler

A completely transistorized wideband antenna multicoupler is available from Trak Electronics Co.

With miniaturized, solid-state, modular construction, the unit operates from 2 to 32 mc in one band and permits simultaneous use of eight receivers from a single antenna. Requiring only 30 watts input power, it has low heat dissipation.



Intermodulation-distortion products are kept low through the use of linear transistor circuitry. Gain is flat over the 2-32 mc band and is constant between channels and units.

Circle No. 226 on Subscriber Service Card

## All Glass Diodes

Six high-speed diffused silicon mesa computer diodes (MA-4303 through MA-4308) with all-glass microminiature packaging are available from Microwave Associates, Inc.

All meet the environmental specifications of MIL-S-19500B.

Reliability has been assured by use of a process in which hard glass is fused directly to the junction, eliminating the need for "surface passivation" and providing bonded contacts with no spring.

The diodes are extremely rugged, and combine exceptionally low leakage with very fast switching speeds—typically 2 nanoseconds.

Circle No. 227 on Subscriber Service Card

## Low Temp Si Rubber

An extreme low-temperature resistant silicone rubber compound, designed for use in molded and extruded seals and gaskets and a wide variety of mechanical applications, is being marketed by the Silicone Products Dept. of G.E.

Designated SE-5401U, the material is a gray, 40-durometer compound which may be used to meet specifications MIL-R-5847D, Class I, Grade 40 and AMS-3334.

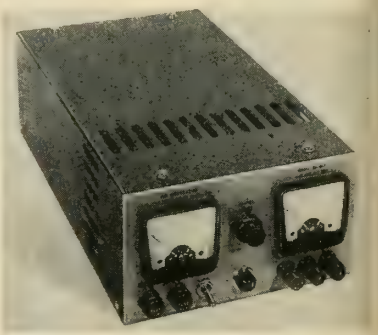
Circle No. 228 on Subscriber Service Card

## Power Supply

A transistorized d-c power supply, called Model TR-18-3, has been introduced by the NJE Corp. The unit provides a 50% increase in power (0-18 volts, 0-3 amperes) over the previous design, with no increase in the size of the supply.

The simple addition of an external resistor converts this unit from a constant voltage to a constant current supply.

Electrical specifications include ±0.03% load regulation, 2-millivolt



peak-to-peak ripple, 50 microsecond response time for a full load step, electronic current-limiting for momentary overloads and automatic load removal on sustained overloads. Either positive or negative output terminal may be grounded, or the entire output may be floated 500 volts above or below ground.

Circle No. 229 on Subscriber Service Card

## Oxygen Gas Filter

A supplemental vapor-contaminant filter is available from A. Biederman, Inc. for removal of water vapor and other contaminants from air, nitrogen, oxygen and similar gaseous matter in pressure lines. Designed primarily as in-line filter, working in conjunction with the main heavy-duty filter, it provides a positive safeguard against contamination that may develop within the air lines.

The unit is 5 in. long and consists of reusable desicant filter, encased in a lastic shell, with molded vinyl tubing, in. long on the receiving end and 4 in. long on the other. Both ends are tted with NPT brass fittings for easy nstallation. The entire unit weighs only alf a pound and is encased in an alumnum shell. Operating pressure is guarnteed safe to 75 psi.

Circle No. 230 on Subscriber Service Card

## .anyard Operated Switch

A four-pole, double-throw switch ombining contact design with a plunger nd spring operating mechanism for osition stability has been developed for nissile use by Kinetics Corp.

The Kinetics unit has successfuly passed high-level sinusodial and random-noise vibration tests in both axes in the normally open and closed positions without contact movement or chatter. The highest vibration level the switch has passed to date has been an equivalent 92 g's rms at 2200 cycles.

Testing was carried out at frequencies from 50 to 2000 cps. If required, switches of this design can be built to withstand even greater vibration.

Circle No. 231 on Subscriber Service Card

## Heat Transfer System

Eastern Industries is marketing an airborne heat transfer system used to cool electronic countermeasure equipment miniaturized to the point where neither convection nor fan cooling is adequate. Designated E/HT-200-214, the unit has a capacity of 3400 watts, and maintains the ethylene-glycol/water coolant between 150 and 170°F by means of a temperature regulating valve.

This cooling pack is designed for operating temperatures from −55° to 55°C, and performs from sea level to 50,000 ft.

Weighing only 25 lbs., it fits within a compact 4.6 x 10 x 20 in. envelope, and requires a power supply of 208 volts, 3 phase, 400 cycles.

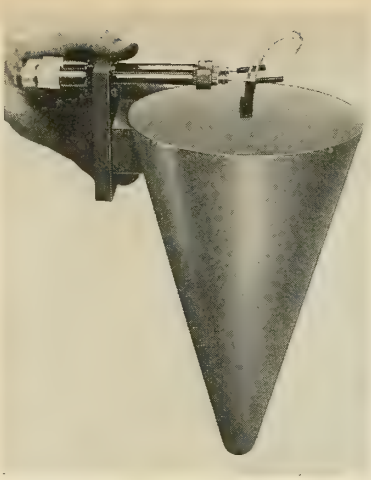
Circle No. 232 on Subscriber Service Card

## Broadband Antennas

A line of broadband antennas is available from the Maryland Division of Litton Systems, Inc.

Vertical, horizontal, left-circular, and right-circular polarizations can be provided in bandwidths of 10 to 1 or greater. The beamwidths and gain of these antennas are essentially constant across the entire operating band.

Models now available are model 12E1-10, which covers the frequency range of 100 to 1000 mc with a gain of 8 ±1 db and a maximum VSWR of 2.0 to 1; and model 13E1-5, which covers the range from 1000 to 5000 mc



with a gain of 7 ±1 db and a maximum VSWR of 2.2 to 1.

Also available is a master control unit. This unit, when used with these antennas, provides a single installation covering 100 to 5000 mc.

Circle No. 233 on Subscriber Service Card

## Lead Sulfide Photo Cells

A complete line of lead sulfied infrared cells is being marketed by Cetron Electronic Corp.

These subminiature, all-glass, hermetically sealed cells are environmentally stable, with pins for socket mount or flexible leads. The line of cells includes a broad range of stock sizes, broken down into several sensitivity ratings.

Circle No. 234 on Subscriber Service Card

# new literature

DRY LUBRICANT—General Magnaplate Corp. has made available a brochure which details the latest results of the use of Hi-T-Lube, a high-temperature dry lubricant. Included in the brochure is full information about Hi-T-Lube together with the new data obtained from exhaustive tests. Hi-T-Lube performed effectively for more than three hours at over 1000°F, where other lubricants and combinations of materials failed in less than five minutes.

Circle No. 200 on Subscriber Service Card

CUTTING TOOLS—The Carborundum Company has published a catalog on Stupalox ceramic cutting tools. It gives the properties data on Stupalox and specs and prices on throw-away inserts, heavy-duty button inserts, solid inserts, unground blanks, single-point tools, and tool holders.

Circle No. 201 on Subscriber Service Card

METAL BELLOWS—An eight-page brochure presenting extensive design and application data concerning welded diaphragm bellows is available from Metal Bellows Corp. It is organized under eight section headings providing a highly concise story of welded-metal diaphragm bellows design and applications. These headings are: Introduction, Basic Diaphragm Contours, Applications for Basic Contours, Illustrations, Definition of Terms, Attaching Bellows, Explanation and Use of Design Curves, and Bellows Materials.

Circle No. 202 on Subscriber Service Card

COPPER-CLAD LAMINATES—Grades XXP-E and XXP-R copper-clad, paper-phenolic laminated plastic, which have excellent punching and machining properties, are described in Technical Data Bulletin No. 3.1.20 published by Taylor Fibre Co. The bulletin gives thickness tolerance of the copper foil, thickness tolerance of copper-clad sheets and the bond strength and heat resistance of the composite sheets.

Circle No. 203 on Subscriber Service Card

CONNECTORS—Details of series 600, 700, 800 circular connectors are described in a two-page illustrated bulletin issued by the Data Recorders Division of Consolidated Electrodynamics Corp. The MS-type connectors are manufactured in accordance with MIL-C-26500 and are designed to meet the stringent environmental requirements of high-performance aircraft, missile, space, and marine vehicle applications.

Circle No. 204 on Subscriber Service Card

SEALED VALVES—A line of hermetically sealed valves for service in pressurized water reactors, and containment of dangerous, toxic radioactive or highly corrosive liquids and gases is described in an 8-page brochure just issued by the Atomic Power Department of United Shoe Machinery Corp. The harmonic drive principle, which permits valve actuation through a completely sealed pressure envelope, is illustrated in two basic forms: rotary input and linear output, and rotary input with rotary output. The application of the principle to globe valves, as well as custom valves and operators is also shown.

Circle No. 205 on Subscriber Service Card

THRUST MEASUREMENT—Technical Bulletin TD-106, released by Gilmore Industries, Inc., describes some typical instrumentation systems for jet-engine test facilities, electronic methods of weight and thrust measurements and calibrations used in ICBM facilities, and an installation at Edwards AFB designed for captive testing of all present and planned aircraft. Also discussed are the various types of secondary standards available for force measurement, as well as the reasons for the decrease in the confidence factor as the secondary standard accuracy approaches the accuracy of the primary standard.

Circle No. 206 on Subscriber Service Card

## Man-in-Space Apathy?

*To the Editor:*

In your editorial "Odd Caution on the New Frontier" (M/R, April 3), the statement—"The implication that *Polaris* is replacing the mobile *Minuteman* will draw no arguments from anyone who has seen what war can do to a railroad"—apparently ignores the real value of a land-based mobile ICBM system. The ICBM mobility concept vastly complicates the problem of single-blow neutralization of our retaliatory forces. The real value is in its war deterrent potential. In any case, destruction of the railroads would not necessarily mean destruction of the mobile ICBM's. These missiles could be transferred overland to existing silos and used to resupply static units, thereby providing an extended counter-blow capability.

The "Odd Caution" regarding the exploitation of "the promising new projects and programs" might better be described as "Gross Neglect." Failure to accelerate our man-in-space (MIS) programs such as *Apollo* and *Dyna-Soar* will surely cause a MIS GAP to occur in the near future. After the "feasibility" of man-in-space is proven in 1961 (the year that the Russians will probably orbit a squad of men) and after the United States orbits a man in 1962, what then?

William E. Howard's article on page 13 of the same issue states that the amount the Air Force would get (in the revised FY '62 budget) to "accelerate the (*Dyna-Soar*) program by 19 months and provide for the first manned flight by mid-1963" is "believed to be less than the $100 million requested." Taking this statement at face value, it seems that during the period 1961-63, no new follow-on manned space operations will occur in the Free World. I wonder if the Russians will stop and wait for us?

It is evident that by the time our big boosters become available for manned space operations, we will not possess man-rated space vehicles to place atop them. Do we really believe that we can match Russian space achievements merely by accelerating our booster programs?

Availability of an operational *Apollo* three-man spacecraft coincident with readiness of the *Saturn C-2* would certainly enhance our position in the space race. Since *Dyna-Soar* flight experience is bound to benefit the *Apollo* program, any delay in *Dyna-Soar* development might have a serious effect on the *Apollo* flight schedule. In any case, if we are not deadly serious about sending men into space, why bother to develop on an accelerated basis such huge boosters and engines as *Saturn C-2* and F-1?

Perpetuation of our apathetic approach to man-in-space could likely result in the absolute denial of our right to explore and ultimately colonize Solar territory. Red domination of our near planets and the moon is a likelihood not to be ignored—so is the posibility of Russian control of near space. Our manned space programs should be given our highest national priority. It is apparent that the Soviet Union placed such emphasis on man-in-space several years ago. If priority is not established, *Prospector's* first great discover as it roams the lunar surface may well be a manned Soviet military base under construction.

Robert H. Jones
Research Engineer
Bellevue, Wash.

## Safety Courses

*To the Editor:*

In the TECHNICAL COUNTDOWN of the Jan. 23 M/R, you reported that the University of Southern Califonia had begun the world's only course in the safe handling of ballistic missiles.

We felt that you would be interested to know that the Customer Training Staff of the Solid Rocket Plant, Aerojet-General Corp., initiated a missile safety and handling course in 1958 for the purpose of training U.S. Navy personnel in the safe handling procedure for the *Polaris*.

Subsequent safety and handling courses have been, and are being conducted for such programs as the *Hawk, Tartar, Skybolt, Genie, Minuteman,* and Aerojet Liquid Propulsion Systems. Safety and and handling is but one course in Aerojet-General's complete curriculum devoted to both solid and liquid-fueled ballistic missiles.

John Z. Ickes
Manager of Public Relations
Sacramento Plants
Aerojet-General Corp.
Sacramento, Calif.

*The* TECHNICAL COUNTDOWN *item was based on a press release from the university. Presumably, the Southern Cal course is the only one of its kind conducted on a college campus.—Ed.*

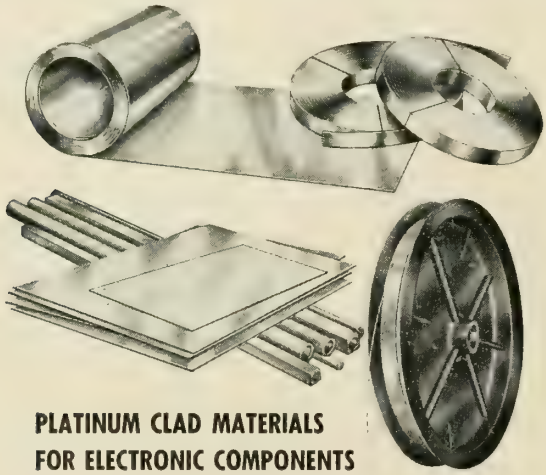
## Infernal Digits

*To the Editor:*

We appreciate very much the reference in M/R, March 27, p. 39, to the ITT Federal Laboratories Electronic Scanning Star Tracker. We note, however, that you refer to a 70-lb. tracker, whereas the actual weight of the unit is 7 lbs.

We would greatly appreciate the printing of a correction concerning the weight of this unit.

H. D. Huffman
Senior Contract Administrator
ITT Federal Laboratories
Fort Wayne, Ind.

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## —when and where—

### APRIL

**Symposium on Structural Dynamics of High Speed Flight (confidential), Aerospace Industries Association and Office of Naval Research,** AIA Auditorium, Los Angeles, April 24-26.

**Aerospace Medical Association, Thirty-second annual meeting,** Chicago, April 24-27.

**Ninth Annual Conference on Electromagnetic Relays, Oklahoma State University,** Stillwater, April 25-27.

**ARS Propellants, Combustion, and Liquid Rockets Conference, American Rocket Society,** Palm Beach Biltmore, Palm Beach, Fla., April 26-28.

**High Temperature Materials Conference, AIME, Cleveland Section,** Pick-Carter Hotel, Cleveland, April 26-27.

**18th Annual Western Section Conference of The Society of the Plastics Industry,** Hotel del Coronado, Coronado, Calif., April 26-28.

**Seventh Region of the Institute of Radio Engineers, 1961 Conference,** Hotel Westward Ho, Phoenix, April 26-28.

**British Interplanetary Society, Symposium on Liquid Hydrogen as a Rocket Propellant,** Royal Aeronautical Society, London, April 28.

## ADVERTISERS' INDEX

AC—The Electronics Div., General Motors Corp. ..... 8
Agency—D. P. Brother & Co.
Aerojet-General Corp., Sub.—The General Tire & Rubber Co. ..... 6
Agency—D'Arcy Adv. Co.
Aerospace Corp. ..... 3
Agency—Gaynor & Ducas, Inc.
AiResearch Mfg. Co., Div.—The Garrett Corp. ..... 24
Agency—J. Walter Thompson Co.
American Bosch Arma Corp., Arma Div. ..... 55
Agency—Doyle, Kitchen & McCormick, Inc., Adv.
American Standard Controls Div. ..... 22
Agency—Gray & Kilgore, Inc.
American Time Products, Inc. ... 45
Agency—H. M. Alexander & Assoc., Adv. Agency
Avco Corp., Research & Advance Development Div. ..... 2
Agency—Benton & Bowles, Inc.
Bendix Corp., The, Scintilla Div. ..... 11
Agency—MacManus, John & Adams, Inc.
Doubleday & Co., Inc. ..... 53
Agency—Franklin Spier, Inc.
Engelhard Industries, Inc. ..... 52
Agency—Stuart Sande, Adv.
Food Machinery & Chemical Corp., Ordnance Div. ..... 43
Agency—The McCarty Co.
General Electric Co., Silicone Products Dept. ..... 13
Agency—Ross Roy-B.S.F.&D., Inc.
Lockheed Aircraft Corp., Georgia Div. ..... 39
Agency—Foote, Cone & Belding
Lockheed Aircraft Corp., Missiles & Space Div. ..... 4
Agency—Hal Stebbins, Inc.
Metal Bellows Corp. ..... 47
Agency—George T. Metcalf Co.
Minnesota Mining & Mfg. Co.... 35
Agency—Batten, Barton, Durstine & Osborn, Inc.
Pan American World Airways, Inc., Guided Missiles Range Div. ..... 33
Agency—Willard E. Botts Adv., Inc.
Reinforced Plastics, Dept. of Raybestos Manhattan, Inc. 10
Agency—Gray & Rogers, Adv.
Strong Electric Corp., The ..... 12
Agency—Wendt Adv. Agency
Thiokol Chemical Corp., Rocket Div. ..... 28, 29
Agency—Hicks & Greist, Inc.
Washington Technological Assoc. ..... 56
Agency—Dawson, MacLeod & Stivers

## editorial . . .

# How We Won the Telegram Race

IT IS HEARTENING to note that President Kennedy has sent Premier Khrushchev a large telegram congratulating the Soviet Union on its achievement in putting the first man into orbit.

We had, in fact, become rather concerned about this vital aspect of the space race. To fall behind in the production of telegraph blanks could do us irreparable harm from a prestige standpoint. To be unable to match a successful Soviet-manned lunar landing with the launching of a massive congratulatory telegram would result in a propaganda defeat of a size to dishearten even Edward R. Murrow.

You will be relieved to learn that the White House has a good supply of large telegraph blanks. This fact emerges from an intensive investigation we have conducted into the U. S. telegraph blank program. Despite some initial setbacks, we find it is moving along at an encouraging step-by-step pace toward objectives which may soon be defined.

We thought you might be interested in the chronology of the U.S. blistering missive program:

1944—German scientists at the Grosser Telegramerwerke achieved considerable early success in the dispatch of telegrams to London although some fell in Geneva and at least one was detected as far away as a railway post office in Cairo, Egypt. An RAF aircraft made a hazardous night landing and returned this telegram to England. After patching it together, British technicians determined that it contained birthday greetings to someone named Helga. RAF and USAF reconnaissance aircraft were immediately assigned to missions to determine the point of origin, since two shillings sixpence were due on the message.

1945—Russian and American intelligence agents descended en masse upon the Grosser Telegramerwerke in an effort to recruit German scientists and technicians with experience in the Nazi program. Although the Soviets succeeded in obtaining the bulk of personnel for their central telegraph office, largely by offering special rates to members of the immediate family, U.S. officials spirited the cream of the crop off to the U.S., where they were assigned to a special project office at Western Union.

1953—The research and development program for Soviet telegraph blank production was moving along at a brisk pace when a breakthrough took place which resulted in a complete re-evaluation of the program. Members of the Soviet Alphabetique Experimentale Cyrillic (AEC) found it was possible to use much smaller cyrillic letters than previously anticipated. This discovery led to a decision to decrease the size of Russian telegraph blanks.

The U.S., meanwhile, having fallen far behind in the field of alphabet miniaturization, was forced into production of gross, unsophisticated telegraph blanks. These consisted of poorly lettered blanks with extremely large spaces for messages.

1957—The U.S. succeeded in sending a telegram all the way around the world with one of its large telegraph blanks. This was hailed as a tremendous propaganda triumph everywhere on the globe. Except in the Soviet Union. Anastas Mikoyan described the blank as a "mere spitball." Premier Khrushchev explained to the Party Congress that smaller Soviet blanks, while unable to carry as many letters, were much less expensive and less of a drain on Soviet taxpayers. Nevertheless, he revealed, an all-out effort was to be made to catch up in the telegraph blank race. No money was to be spent on this.

1959—The U.S. had by this time sent several lengthy telegrams around the world on its unsophisticated blanks. Premier Khrushchev explained in a telecast from Moscow that the Soviet Union has sent a far greater number of small telegrams of two words each. Although admitting it was difficult to say much in only two words, Mr. Khrushchev pointed out the successful miniaturization of the cyrillic alphabet which made this volume of messages possible. He held up one or two letters for the audience to see.

1961—Premier Khrushchev promised the Soviet people an all-out effort to catch the United States in the telegraph blank race. Several approaches were being studied, he said, and as soon as one appeared sufficiently promising some money would be spent. Meanwhile, he revealed, a large telegraph blank was being assembled in the southern province of Azerbaijan. This would be ready to send in 1965, although it was not yet determined what the message should say.

Several members of the Party Congress objected to this program, questioning whether there was any need at all for telegraph blanks. Smoke signals had served very well for years, they pointed out.

EARLY IN THE YEAR, Premier Khrushchev was forced to admit to Yuri Gagarin, a Soviet citizen who had just returned from space, that the United States had sent the most massive telegram to date.

At the same time, the U.S. announced its intention of sending a telegram to the moon. Premier Khrushchev promised an all-out effort to match this feat, although the program was not to be a crash program and no money would be spent.

A disheartened Yuri Gagarin conceded that the most he could hope for was to be on the moon to receive the U.S. telegram.

**William J. Coughlin**




# *Arma navigates new routes*

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